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DIFFERENTIAL EFFECTS OF GOAL SETTING AND VALUE REAPPRAISAL ON COLLEGE WOMEN'S MOTIVATION AND ACHIEVEMENT IN STATISTICS

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DIFFERENTIAL EFFECTS OF GOAL SETTING AND VALUE REAPPRAISAL ON COLLEGE WOMEN'S MOTIVATION AND ACHIEVEMENT IN STATISTICS

by

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DIFFERENTIAL EFFECTS OF GOAL SETTING AND VALUE REAPPRAISAL ON COLLEGE WOMEN'S MOTIVATION AND ACHIEVEMENT IN STATISTICS

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The University of Texas at Austin, 2009

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The purpose of this dissertation was to investigate the differential effects of goal setting and value reappraisal on female students' self-efficacy beliefs, value perceptions, exam performance and continued interest in statistics. It was hypothesized that the Enhanced Goal Setting Intervention (GS-E) would positively impact students' self-efficacy beliefs and exam performance, whereas the Enhanced Value-Reappraisal (VR-E) was expected to positively affect students' value perceptions and continued interest in learning statistics.

A total of 88 female undergraduate students enrolled in two sections of an introductory statistics course completed the entire study. Students were primarily Caucasian, upper division, and traditionally aged. Students were stratified on course section and year in school and randomly assigned to one of three groups: Control Group (n=30); GS-E Group (n=27); and VR-E (n=31).

GS-E asked students to both set and self-evaluate eight goals focused on reaching learning objectives for their upcoming statistics exam. VR-E presented students with messages about why learning statistics could be important for them and guided them in processing these messages. The Control Condition asked students to complete three Texas Information Literacy Tutorial modules and answer reflective questions.

Findings from this dissertation partially supported the hypotheses related to VR-E, but no support was found for the hypotheses related to GS-E. The VR-E Intervention was found to positively impact measures of students' value perceptions and continued interest. Immediate effects of VR-E were observed on: 1) the overall value students placed on learning statistics; 2) students' interest and enjoyment of statistics; 3) the importance students placed on developing statistical knowledge and skills for the attainment of their future goals; and 4) students' intentions to continue learning statistics on their own. However, relatively stronger and longer-lasting effects were observed on the later two variables. Also, students in the VR-E Group outperformed students in the GS-E Group on their post-intervention exam; however, neither group was significantly different from the Control Group.

Findings from this research help to address the growing economic and social needs for the development and evaluation of theory-based educational interventions that target the improvement of college students' achievement and continued interest in math and science education.

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Chapter 1

Introduction

The U.S. Department of Education and National Science Foundation have identified that there are growing economic and social needs to increase students' achievement and continued interest in math and science education; and that these needs are particularly strong for underrepresented ethnic minorities and women (National Science Foundation, 2006; U.S. Department of Education, 2006). While much educational intervention research has focused on helping students build their confidence and improve their academic achievement, much less intervention research has focused on helping students to place value on and develop a continued interest in a particular subject area. It would seem that helping students increase their achievement in a subject would also help them develop a continued interest in that subject. While this may be true to some extent, more recent research in the area of expectancy-value theory and self-regulation theory has suggested that variables typically targeted to improve achievement may not be the same variables that are most strongly related to students' continued interest in a subject area. This suggests that increasing students' continued interest in math and science might require interventions with different foci than the ones aimed at boosting achievement. This dissertation study examined the differential effects of two educational interventions with different foci on students' continued interest and achievement. The focus of the dissertation study was on female students enrolled in

undergraduate, introductory statistics courses – a subject that involves both math and science.

Expectancy-value theory posits that students' academic motivation (e.g., choice, effort, and persistence) and achievement (e.g., exam scores, course grade, and cumulative grade point average) can, in part, be explained by their expectations about successfully performing academic tasks and the degree to which they value those tasks (Eccles, et al., 1983). Students are thought to choose and be motivated towards academic tasks and goals that they expect they can successfully complete and perceive as valuable. Although both expectation beliefs and value perceptions have been found to be positively related to motivation and achievement (Simpkins, Davis-Kean, & Eccles, 2006; Wigfield & Eccles, 1992, 2000), expectation beliefs have been found to be stronger predictors of achievement, and value perceptions have been found to be stronger predictors of continued interest (e.g., enrollment in and intentions to take math courses) (Meece, Wigfield, & Eccles, 1990; Wigfield & Eccles, 1992, 2000). Based on these findings, helping students to increase their expectation beliefs might lead to stronger gains in achievement, and helping students increase their value perceptions might lead to stronger gains on measures of continued interest.

Theory and research on self-regulation has suggested that students can actively modify their academic values, beliefs, and goals through the use of self-regulatory strategies (e.g., Pintrich, 2000, 2004; Wolters, 1998, 2003; Zimmerman, 1989, 2000). Guiding students in using self-regulatory strategies is, thus, one approach to helping students place greater value on learning, build confidence in their academic abilities,

invest energy in their courses, and succeed in college.

A substantial body of research has suggested that students can increase their self-efficacy beliefs (a type of expectation belief related to students' confidence in their capabilities to successfully perform a task) and task performance through the use of self-regulatory strategies related to goal setting and self-evaluation (Bandura & Schunk, 1981; Kitsantas, Reiser, & Doster, 2004; Locke & Latham, 1990, 2002; Schunk, 1983, 1991; Schunk & Ertmer, 1999; Zimmerman, Bandura, & Martinez-Pons, 1992). Goal setting is believed to impact self-efficacy and task performance because goals can direct students' learning behaviors and help them to be more strategic at accomplishing academic tasks (Schunk, 1996). For example, research has supported that setting proximal sub-goals (short-term goals that are instrumental in the attainment of a long-term goal) or process goals (goals focused on methods or strategies that can help with mastering a concept or skill) can lead to increases in students' self-efficacy and task performance (Bandura & Schunk, 1981; Kitsantas, Reiser, & Doster, 2004). Evaluating the progress that is made towards a goal (self-evaluation) has also been found to have positive impacts on self-efficacy and task performance because doing so can help students to become aware of and correct their mistakes and misconceptions, lead to more effective planning, and help sustain their motivation (Schunk, 1996; Schunk & Ertmer 1999). Goal setting and self-evaluation are thus two self-regulatory strategies that have been found to help students increase their self-efficacy and task performance.

Intervention research on goal setting and self-evaluation in educational settings has largely focused on embedding self-regulatory prompts within teacher instructions and

academic tasks in order to prompt students to adopt goals and self-evaluate their goal progress. Much less research has guided students in writing out goals for themselves and keeping track of their goal progress outside of class. Furthermore, a search of research literature on goal setting and self-evaluation interventions did not yield any interventions specific to the area of introductory statistics courses. In this dissertation study, the Enhanced Goal Setting Intervention (GS-E) that I developed was designed to guide students in setting eight proximal process goals for reaching two of their learning objectives in their introductory statistics course. Students were asked to self-evaluate the progress they made towards reaching their goals and learning objectives four times over a 2-week period. GS-E was hypothesized to positively impact students' self-efficacy and achievement in their statistics courses.

While a considerable amount of theory and research exists on how to help students increase their self-efficacy beliefs and achievement, there is currently not much theory or research focused on how to help students positively reappraise the value of learning in a particular subject area (referred to here as value reappraisal) (Brophy, 1999; Pintrich, 2000, 2004; Wolters, 1998, 2003). For this study I developed a conceptual model of value reappraisal. This theory combines disparate research conducted by educational psychologists and social psychologists in the areas of persuasion, expectancy-value, and self-regulation theories. The basic premise of this Value Reappraisal Theory (VRT) draws on what was proposed by persuasion and attitude change researchers over 40 years ago.

Rooted in information processing theory, a basic tenant of models of persuasion (Petty & Cacioppo, 1986), attitude change (Greenwald, 1968), and conceptual change (Dole & Sinatra, 1998) is that processing or elaboration of a message increases the potential for attitude change. Processing a message favorably increases the potential for attitude change in the direction advocated in the message; processing a message unfavorably increases the potential for attitude change in the opposite direction from what was advocated in the message (Bohner & Schwarz, 2001; Greenwald, 1968; Petty, Ostrom, & Brock, 1981). The effect of a persuasive message on a students' attitude is, therefore, believed to be mediated by the students' cognitive responses to the message. This indicates that presenting students with messages about why an academic task, course, or subject area may be valuable and then guiding them in processing these messages favorably could help them to positively reappraise the value of that task, course, or subject area.

Educational psychologists have suggested that providing students with messages about different reasons why an academic task might be valuable is one approach that could help students to positively reappraise the value of a task (Brophy, 1999; Hofer, 2002). Current conceptualizations of students' value perceptions put forth by Eccles and Wigfield postulate that students might value a task for different reasons and their framework could be used to help explain to students the potential value of a task. For example, a student may value a task because it is generally important and in line with their self-concept (attainment value), useful for achieving their future goals (utility value), or enjoyable in and of itself (intrinsic value) (Eccles, 2005; Eccles, et al., 1983;

Wigfield & Eccles, 1992, 2000, 2002). In addition, the cost of task engagement (e.g., time, effort, and negative emotions) is another type of value perception (Eccles, et al., 1983) that could be addressed in a value reappraisal message. Reappraising a task's value may also involve the active use of strategies, and interventions could guide students in using such strategies.

Wolters (1998) found that students reported using strategies to enhance task value in order to increase their motivation; especially in situations where they initially appraised the material as irrelevant. Students reported strategies such as trying to make the task personally relevant, finding ways that the task could be useful in future situations, and trying to make the task more enjoyable. Helping students actively brainstorm different reasons and generate rationales for the importance of learning course material might help them to modify their course-related value perceptions and continued interest in that subject area. Using imaginative processes (Markus & Nurius, 1986; Pham & Taylor, 1999; Singer, 1975) to explore the value of learning (e.g., imagining experiencing positive incentives associated with task success) might also be an important strategy involved in generating value perceptions. For example, Singer (1975) showed that most all humans daydream and use imaginative processes to elaborate thoughts and ideas and that these processes are instrumental in linking cognition, emotion, and motivation. Furthermore, Markus and Nurius (1986) suggested that imaginative processes are involved in the elaboration of future possible selves, which are schemata that serve to motivate people towards the futures that they envision for themselves. Lastly, contrasting benefits of learning with costs of task engagement has been found to help motivate

students to commit to learning their course material (Oettingen, Pak, & Schnetter, 2001). In sum, these strategies discussed above could be used to help students explore and elaborate the importance of a task, course, or subject area.

In this dissertation, the Enhanced Value Reappraisal Intervention (VR-E) I developed presented students with messages about the importance of becoming an intelligent consumer of statistics in everyday life (attainment value), academic and professional uses of statistics (utility value), and the intrinsic enjoyment of learning statistics (intrinsic value). Students also completed activities that guided them in using value reappraisal strategies. Students were asked to brainstorm, generate rationales, imagine, and contrast pros and cons related to the importance of increasing their statistical knowledge and skills.

In my master's thesis (Acee, 2007), I examined the main and interactive effects of goal setting and value reappraisal on undergraduate introductory statistics students' expectation beliefs, value perceptions, exam performance, and continued interest in statistics. I had hypothesized that the Goal Setting Intervention (GS) would lead to increases in students' expectation beliefs and exam performance. The Value Reappraisal Intervention (VR), on the other hand, was hypothesized to increase students' value perceptions and continued interest in statistics. Findings supported the hypotheses related to VR but did not support the hypotheses related to GS. No interaction effects were detected.

One reason I proposed for why GS was not effective is because the intervention was focused on helping students set course goals in general and did not focus students on

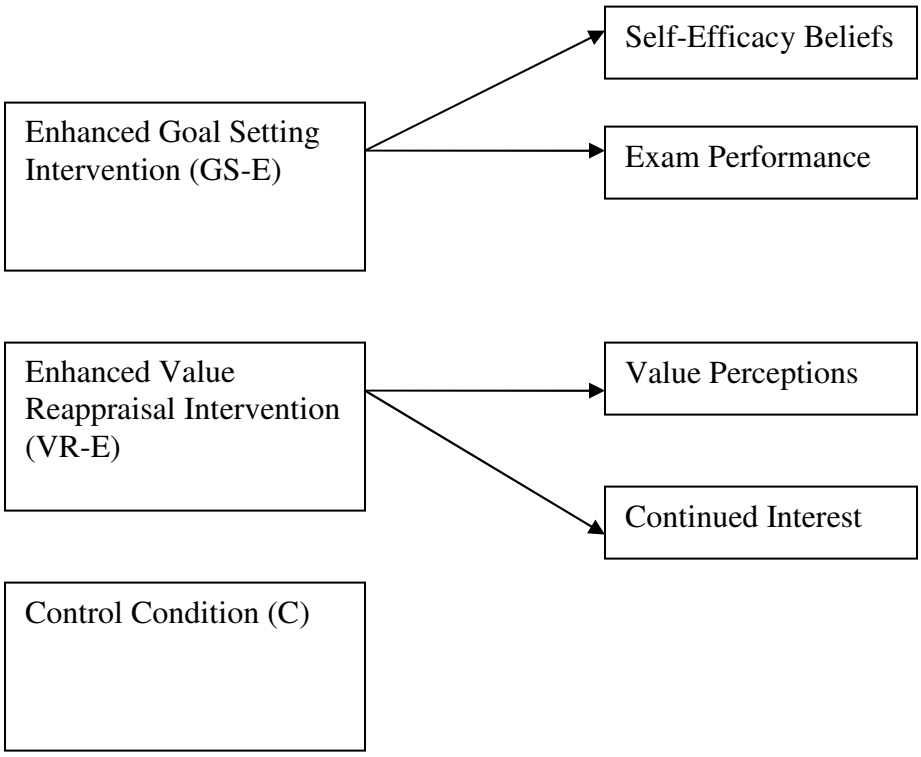
setting goals for the course exam that was being used as an outcome measure. Furthermore, students were free to set process or product goals. Helping students set process goals (i.e., goals focused on the methods and strategies they will use to learn course concepts and master course skills) might have been more effective at increasing their self-efficacy and exam performance than setting product goals (i.e., goals focused on obtaining an outcome like a grade). Also, students were only required to self-evaluate the progress they made towards their goals once. More frequent self-evaluation might have been more powerful. The goal setting intervention tested in this dissertation study (GS-E) had a more specific focus (students were asked to set goals focused on the methods and strategies they would use to reach two learning objectives for their next statistics exam) and required more frequent (four compared to one) self-evaluations of goal progress.

The value reappraisal intervention tested in this dissertation study (VR-E) had the same focus, components, and flow as the one tested in my master's research (Acee, 2007). However, several revisions and enhancements were made. First, minor revisions were made to the wording of the intervention so that it would be more clear and comprehensible to the average college student. Second, in my master's research the opening section of the intervention was on the importance of developing a positive attitude for college courses in general. In my dissertation study, this section was revised to focus on students' introductory statistics course, not college courses in general. Third, in the section on intrinsic value, three additional examples were provided and an

additional step was added that asked them to choose strategies that they could use to increase their intrinsic value for their statistics course.

The purpose of this dissertation was to test the differential effects of the Enhanced Goal Setting Intervention (GS-E) and the Enhanced Value Reappraisal Intervention (VR-E) on students' self-efficacy beliefs, value perceptions, exam performance, and continued interest in statistics. A Control Condition (C) was also included (students completed three Texas Information Literacy Tutorial modules and answered reflective questions about what they learned). It was hypothesized that GS-E and VR-E would differentially affect the study outcomes. Students who received GS-E were hypothesized to make significant gains on self-efficacy beliefs and exam performance, whereas, students who received VR-E were hypothesized to make significant gains on value perceptions and continued interest in statistics (see Figure 1). The interaction between GS-E and VR-E was not tested in this dissertation study due to limitations in sample size in the two course sections available for this study.

Figure 1. Hypothesized causal influences of interventions on outcome variables.



Note: A line between an intervention and an outcome variable represents a positive causal relationship. Self-report measures of self-efficacy, value perceptions, and continued interest in statistics were measured at three time points (pre-test, immediate post-test, and 2-week delayed post-test). Intervention effects on these variables were hypothesized to be observed both at the immediate post-test and the 2-week delayed post-test. Intervention effects were also hypothesized to be observed on a choice-behavior measure of continued interest in statistics and exam performance that were measured after the 2-week delayed post-test. The Control Condition was hypothesized to have no impact on any of the outcomes.

The selection criteria used for this study were: 1) female; 2) undergraduate; and 3) enrolled in either Section A or Section B of an Introduction to Statistics course. This resulted in a sample size of 88 students. Participants were stratified on course section and year in school and randomly assigned to one of three conditions: Control (n=30), Enhanced Goal Setting (GS-E; n=27), and Enhanced Value Reappraisal (VR-E; n=31). A repeated measures design was used: pre-test (immediately before the intervention), post-test (immediately after the intervention), and 2-week delayed post-test (2 weeks after the intervention). The following self-report dependent measures were collected: 1) self-efficacy for course tasks (SECT); 2) self-efficacy for exam performance (SEEP); 3) self-efficacy for reaching learning objectives (SERLO); 4) overall task value (OTV); 5) endogenous utility value (END-UV); 6) exogenous utility value (EXO-UV); 7) intrinsic value (IV); and 8) intentions to continue learning statistics (ICLS). With students' consent, exam scores were collected from their instructors. Also, a choice-behavior measure of continued interest in statistics was collected by posting websites related to statistics on the course website and tracking which students accessed those statistics websites. Interventions were delivered in the form of Microsoft Word 2003 (Microsoft Corporation, 2003) files and completed on a computer in a computer lab room on campus. Students completed the surveys and self-evaluated goal progress online using Survey Monkey (SurveyMonkey.com, 2008).

Findings from this dissertation partially supported the hypotheses related to the VR-E Intervention, but no support was found for the hypotheses related to the GS-E Intervention. The GS-E Intervention was not found to positively impact any of the study

outcomes. These null findings showed that the enhancements that were made to the goal setting intervention were not sufficient to increase its effectiveness. In addition, these findings call into question the application of research on goal setting and self-evaluation for the development of short-term interventions like the GS-E Intervention.

The VR-E Intervention was found to positively impact measures of students' value perceptions and continued interest. Immediate effects of VR-E were observed on the overall value students placed on learning statistics (i.e., OTV), the importance students placed on developing statistical knowledge and skills for the attainment of their future goals (i.e., ENDUV), students' interest and enjoyment of statistics (i.e., IV), and students' intentions to continue learning statistics on their own (i.e., ICLS). However, relatively stronger and longer-lasting effects were observed on ENDUV and ICLS (the positive impact of VR-E on these measures had medium/large to large effect sizes and these effects were observed both immediately after receiving the intervention as well as 2 weeks later). Findings related to OTV and ENDUV were comparable to findings from my master's theses. However, three new findings were observed in this study compared to my master's thesis. First, VR-E was found to positively impact IV, something I had not found in my master's thesis. Enhancements were made to VR-E to improve the section on intrinsic value and that could help to explain why VR-E positively impacted IV. Second, ICLS was not measured in my master's thesis. Therefore, this study helped to extend research on the positive effect of value reappraisal to students' intentions. Thirdly, findings suggested that students in the VR-E Group outperformed students in the GS-E Group on their post-intervention exam. The average exam score for the Control Group

was in between the average scores of the VR-E Group and GS-E Group, and no groups were significantly different from the Control Group. This finding provided very tentative evidence suggesting that the VR-E Intervention may have helped to facilitate students' exam performance.

This dissertation study helps to address the growing economic and social needs for theory-based educational interventions that target the improvement of college students' achievement and continued interest in math and science education. Findings from this research provide evaluative data on the effectiveness of two different online theory-based interventions: one which was designed to target students' value perceptions and continued interest (the VR-E Intervention) and another which was designed to target students' self-efficacy and achievement (the GS-E Intervention). This research suggested positive effects of the VR-E Intervention on students' value perceptions and continued interest in learning statistics. However, more work is needed to design an effective goal setting intervention in the area of introductory statistics. This research could help to integrate research on expectancy-value and self-regulation theories by investigating the effects of goal setting and value reappraisal on expectancy, value, motivation, and performance outcomes. In addition, this dissertation could help to inform instruction and interventions aimed at helping women learn and become more motivated towards learning statistics.

Chapter 2

Review of the Literature

The following literature review will focus on theory and research related to motivation, self-regulation, and the self-regulation of motivation. Expectancy-value theory will be used to organize motivation research on students' expectation beliefs and value perceptions and their differential relationships with achievement and continued interest. Self-regulation theory will be used to frame research focused on the effects of goal setting and self-evaluation on expectation beliefs and task performance. Value reappraisal theory will be used to organize relevant research on the modification of students' value perceptions and continued interest. The review will be presented in the following order: historical overview, expectancy-value theory, self-regulation theory, and value reappraisal theory.

Historical Overview

Introspective psychologists of the late nineteenth and early twentieth centuries drew on the work of ancient philosophers such as Aristotle, Democritus, Quintilian, and Comenius to explore the complexities of human cognition, emotion, and motivation (Berliner, 1993; Pintrich & Schunk, 2002; Weinstein & Way, 2003). Early introspective theories put forth by Wilhelm Wundt (see Wundt & Titchener, 1904) and William James (see James, 1890) suggested that internal forces (e.g., instincts, traits, will, and volition) influenced human behavior and that consciousness could direct its own attention (Hilgard, 1996; Hunt, 1993; Pintrich & Schunk, 2002). These ideas built the foundation for later work in the areas of human motivation and self-regulation (Weinstein & Way,

2003). However, many of the ideas put forth by introspective psychologists were speculative and not grounded in empirical research.

Reacting against introspective psychology and towards ideals of objective science, behaviorist researchers such as John Watson, Edward Thorndike, Ivan Pavlov, and Burrhus Skinner simplified the study of human motivation by ignoring psychological variables altogether and focused solely on the effects of environmental stimuli on behavioral responses. Behaviorist researchers found that people were more likely to increase a behavior when it was rewarded and decrease a behavior when it was punished (Skinner, 1953; Watson, 1924). This finding, that human behavior could be conditioned through rewards and punishments, was a major contribution to theory on human motivation (Pintrich & Schunk, 2002).

Drive theorists such as Clark Hull and Robert Woodworth believed that motivation was also a function of the human propensity to maintain homeostasis by satisfying universal, physiological needs (e.g., hunger) that were represented in the psyche as drives (Weiner, 1985). Drives were viewed as innate mechanisms for survival (Hull, 1943) and variation in human motivation was hypothesized to be partially explained by the intensity, direction, and persistence of a drive (Woodworth, 1918). Drive theorists expanded behaviorists' stimulus-response models to include the organism's drives as a moderating factor. While many of the theoretical ideas put forth by behaviorists and drive theorists were based on empirical evidence and rooted in rigorous science, the degree of control and objectivism these approaches required limited

them in examining important psychological variables such as cognition, emotion, and executive functioning.

Humanistic psychologists such as Abraham Maslow and Carl Rogers took a holistic approach to the study of motivation that emphasized the importance of studying human behavior, thought, and feeling (Hunt, 1993; Pintrich & Schunk, 2002). They proposed that humans, unlike lower-level species who were primarily motivated by basic needs, possessed universal tendencies to maximize their potential and exercise control over their lives (Rogers, 1969; Weiner, 1985). These ideas expanded drive theorists' definition of a need to include needs for safety, belongingness, ego, and self-actualization (Maslow, 1943). In addition, the humanistic movement led to a finding that stood in the face of fundamental behaviorist notions – that reward and punishment can undermine a person's intrinsic motivation for a task (Deci, 1971). Humanistic researchers acknowledged the complexities of human motivation and led researchers to find creative ways to study them scientifically, even if at times it meant sacrificing some degree of experimental control and relying on subjective data.

Contemporary social-cognitive views have postulated that emotions (e.g., feelings of learned helplessness, anxiety, guilt, and pride), motivational values, beliefs and goals (e.g., attributions, self-efficacy, values, goal properties, and goal orientations), and self-regulatory processes (e.g., goal-setting, planning, self-monitoring, self-evaluation, and motivation regulation) influence motivation (e.g., choice, effort, and persistence) and, unlike an innate need or universal human tendency, are learned and shaped through reciprocal interactions with environmental, behavioral, and personal variables (Eccles &

Wigfield, 2002; Pintrich & Schunk, 2002). Social-cognitive models have re-conceptualized the linear nature of stimulus-organism-response models as reciprocal; that is, environmental (stimulus), personal (organism), and behavioral (response) variables can impact and be impacted by one another. Furthermore, social-cognitive models have deemphasized the role of universal human needs in explaining behavior; and instead, centered on motivational values, beliefs and goals that are learned, and on self-regulatory processes that can be used to modify one's own thoughts and behaviors. This portrays the human as more self-controlling than motivation theories of the past. Accordingly, much intervention research in this area has focused on providing students with strategies that they can use to modify and regulate their learning behaviors. This dissertation is rooted in social-cognitive theory and focused on the self-regulation of expectation beliefs, value perceptions, task performance, and continued interest through self-regulatory processes related to goal setting, self-evaluation, and value reappraisal.

Expectancy-Value Theories

According to expectancy-value theorists, people's expectations about the likelihood of succeeding on a task and perceptions about the value, or importance, of a task are used to decide which tasks to pursue, how much energy to expend, and how long to persist (Atkinson, 1964; Eccles, et al., 1983; Heckhausen & Kuhl, 1985). Believing that success is possible is necessary for motivation. If a person had no expectation of succeeding on a task, from that person's perspective, it would be pointless to put effort towards accomplishing that task. People are also more likely to expend energy on tasks that they perceive as being important compared to tasks that have little value to them.

When choosing what classes to take, what major to go into, or whether or not to reenroll for another semester of college, expectancy-value theorists believe students are basing these decisions partly on the perceived value and likelihood of success of the options (Feather, 1988, 1992; Wigfield & Eccles 1992, 2000). Being that expectations and values underlie students' choices, effort, and persistence in college, these variables could be targeted to impact student motivation and achievement.

One of the earliest conceptualizations of expectancy-value theory in psychology was Atkinson's (1964) expectancy x value model. Atkinson theorized that motivation for a given task was equal to the product of one's expectation of success and value of that task. Therefore, if either expectation of success or value equaled zero, no motivation would be predicted to result. Atkinson (1964) also assumed that expectation of success and value were inversely related. He posited that people tend to place more value on difficult tasks and less value on easier tasks. In his research, Atkinson only measured expectation of success and derived value by taking the inverse of expectation of success (Atkinson, 1964).

In contrast to Atkinson's model, Battle (1966) demonstrated that value and expectation of success were positively related not inversely related. Under this notion, increasing one's expectation of success would not necessarily result in a lowering of task value. Battle (1966) measured value separately from expectation of success allowing it to vary freely. Battle also distinguished between absolute attainment value (i.e., the overall value an individual places on a task) and relative attainment value (i.e., the value of a task

relative to other tasks). Atkinson and Battle laid much of the groundwork for later research on expectancy-value theory within educational settings.

Current expectancy-value researchers differentiate between different types of expectation beliefs (e.g., self-efficacy, outcome expectations, and general expectations of success) and value perceptions (e.g., attainment value, utility value, intrinsic value, and cost). Research in this area has suggested that expectation beliefs and value perceptions are positively related, not inversely related as Atkinson assumed, and correlations typically range between .3 and .4 (Wigfield & Eccles, 2000). It is also important to note that most of the research in this area has been conducted at the task or course level, that is, students are asked to respond to items that refer to a specific task, K-12 class, or college course.

Expectation Beliefs

While Heckhausen (1991) discussed general expectation beliefs which refer to the expected likelihood of attaining a desired outcome, Bandura (1986, 1997) differentiated between two kinds of expectation beliefs: self-efficacy and outcome expectations. Self-efficacy was defined as students' confidence in their capabilities to accomplish a task, whereas, outcome expectation was described as students' expectations about the likelihood that accomplishing a task would result in a desired outcome (Bandura, 1986, 1997). While not much research has been conducted on outcome expectations, a great deal of research has been conducted on self-efficacy beliefs.

All else being equal, when students have high self-efficacy for a task, they are more likely to engage in the task, put effort towards it, and persist in the face of

difficulty. Researchers have found self-efficacy to be predictive of student motivation, use of learning strategies, use of meta-cognitive strategies, and achievement. For example, Zimmerman, Bandura, and Martinez-Pons (1992) found that students with higher self-efficacy beliefs were more likely to set more difficult goals as well as exert more effort to reach those goals. Pintrich and De Groot (1990) found that students with higher self-efficacy were more likely to use cognitive and meta-cognitive strategies and were also more likely to persist longer at the focal task. Even when controlling for actual ability levels, self-efficacy has been found to remain a powerful predictor of learning and achievement (Bandura, 1986; Pajares, 1996; Zimmerman, Bandura, & Martinez-Pons, 1992). Helping students develop confidence in their capabilities to accomplish academic tasks seems to be a crucial component for helping students succeed in college and develop themselves as strategic and self-regulated life-long learners. However, it is also important for students to perceive academic tasks as worth while and valuable.

Value Perceptions

Current conceptualizations of task value put forth by Eccles and Wigfield break task value into four constructs: intrinsic value, utility value, attainment value, and cost (Eccles, et al., 1983; Eccles, 2005; Wigfield & Eccles, 2002). These constructs refer to different reasons why students might value a task. What follows is a description of these constructs, the interrelationships among them, and their relationships with educational outcomes.

Intrinsic value refers to the value one places on a task because of the anticipated enjoyment or pleasure that would be derived from task engagement. Intrinsic value is

similar to Deci and Ryan's (1985) definition of intrinsic motivation as well as Csikszentmihalyi's (1975) concept of flow. When students' enjoy completing academic tasks or are interested in the subject matter of their courses, they are more likely to actively engage in the task, persist, and achieve at higher levels (Wigfield & Eccles, 1992).

While students may not find a particular task intrinsically enjoyable, they may find it useful for attaining their goals. Utility value refers to the usefulness of accomplishing a task for the attainment of other goals (Eccles, et al., 1983). With a foundation in Future Time Perspective (FTP) theory (e.g., Nuttin & Lens, 1985), Husman and her colleagues added to expectancy-value notions of utility value by suggesting two different types of utility value (Husman & Lens, 1999; Husman, Derryberry, Crowson, & Lomax, 2004). Endogenous utility value refers to the perceived usefulness of developing knowledge and skills related to a task for the attainment of future goals. For example, a student interested in becoming an engineer may value learning mathematics because the student believes that math skills will be important for a career in engineering. Exogenous utility value refers to the usefulness of performing well on a task for the achievement of future goals. A student interested in becoming a veterinarian may not value developing math skills but may value getting high scores in math courses because it will be instrumental for getting into a good veterinarian graduate program. It is important that students see the usefulness of learning course concepts and building course skills for the attainment of their future goals because this attitude can help to motivate students to learn. For example, Husman, Derryberry, Crowson and Lomax (2004) found that students

who spent more time studying also rated themselves higher on endogenous utility value. In addition, Husman and Hilpert (2007) found that endogenous utility value, self-efficacy, and self-regulation measured at the end of the semester were positively related to and explained unique variation in course performance.

Attainment value has been defined as the degree to which a student values a task because it is in line with the student's personal values, identity, or self-schema (Wigfield & Eccles, 1992). Generating items to measure attainment value has been difficult because personal values and identity are abstract and difficult to describe in an item. Consequently, researchers have often written attainment value items that ask students to consider the value they place on a task in general (e.g., how important is this task to you).

Cost involves the perceived costs of engaging in a task. Potential costs could include perceived effort of task engagement, anticipatory negative emotions related to task engagement (e.g., anxiety), and not being able to engage in other tasks (Eccles, et al., 1983). Cost has not received as much research attention as the other three components but is believed to be an important aspect involved in decision making (Pintrich & Schunk, 2002).

Students' perceptions of the attainment value, utility value, intrinsic value, and cost of a task are believed to be taken into account collectively when making a decision (Eccles, et al., 1983). This has lead researchers to be interested in the overall value students' place on academic tasks. Researchers have measured the overall value of a task by combining items from multiple task value components into one measure. For example, the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, et al., 1991)

contains items that assess intrinsic, utility, and attainment value. Those items are averaged to obtain an overall task value score. Measures of overall task value have consistently been found to predict student motivation (Bong, 2001; Eccles & Wigfield, 1995; Pintrich, et al., 1991).

Research has suggested that each component of task value is empirically distinguishable but also interrelated to some extent. Results from confirmatory factor analyses have suggested that attainment value, utility value, and intrinsic value are empirically separable constructs (Eccles & Wigfield, 1995). Furthermore, Husman, Derryberry, Crowson, and Lomax (2004) showed that endogenous utility value was empirically distinguishable from overall task value and intrinsic motivation despite the positive relationships among the three constructs. While expectation beliefs and value perceptions have different facets and sub-components, research has most often addressed self-efficacy and overall task value when attempting to explain and predict student motivation and achievement.

Differential Relationships of Expectation Beliefs and Value Perceptions with Outcomes

An extensive amount of research has been conducted on students' expectation beliefs and value perceptions, and these variables have been used successfully to predict students' achievement and continued interest in a particular subject area (Eccles, 2005; Simpkins, Davis-Kean, & Eccles, 2006; Wigfield & Eccles, 1992). Interestingly, expectation beliefs have been found to be stronger predictors of achievement, while value perceptions have been found to be stronger predictors of choice-behavior measures of

continued interest (e.g., course enrollment intentions and decisions) (Joyce & Farenga, 2000; Meece, Wigfield, & Eccles, 1990; Wigfield & Eccles, 1992, 2000). For example, in a study on 250 seventh- through ninth-grade students, Meece, Wigfield, and Eccles (1990) found that expectation beliefs directly predicted subsequent math grades and value perceptions directly predicted intentions to enroll in math courses. Furthermore, this pattern of results held for both boys and girls. Based on these findings, helping students to make choices to continue to learn in a particular subject area might be better facilitated by helping them to increase the value they place on learning more in that area. Alternatively, helping students to increase their academic performance may be better facilitated by focusing on building their expectation beliefs.

Because of the major role students' expectancies and values play in self-regulation, motivation, and performance, it is important that these variables are integrated within models of self-regulation and that self-regulation intervention research target these variables (Wigfield & Eccles, 2002; Pintrich, 2000, 2004; Zimmerman, 2000). Theories of self-regulation suggest that students' can use self-regulatory strategies to modify their expectation beliefs, value perceptions, task performance, and continued interest (Pintrich, 2000, 2004; Wolters, 1998, 2003). In this dissertation study, two self-regulation interventions with different foci were tested to see if they differentially impacted these outcomes. What follows is a review of important theory and research in the area of self-regulation that was used to inform the interventions being tested in this dissertation.

Self-Regulation Theories

Four Common Assumptions of Self-Regulation Theories

Pintrich (2000) argued that self-regulation theories have four common assumptions. First, the active constructive assumption postulates that students are not passive receptacles of information and instead actively construct meaning and goals. Second, the potential for control assumption posits that students have the potential to control their own thoughts, motivations, behaviors, and, to a lesser extent, the environment. Third, the goal criterion or standard assumption suggests that students can set goals, evaluate their progress towards those goals, and use goal feedback to inform future decisions. The fourth assumption posits that the effects of personal and contextual variables on educational outcomes are indirect because they are mediated by self-regulation variables that are believed to be the direct cause. Collectively these assumptions support the notion that students can use strategies to develop themselves as learners and improve their chances of success. Students are not believed to be restricted by impenetrable barriers to achieving their goals like socio-economic status or innate ability. Instead, students are assumed to be able to exercise some degree of control over the cognitive, motivational, affective, behavioral, and environmental variables that are impacting their success.

Overview of Self-Regulation Theory

Central to models of self-regulation are processes involved in setting, pursuing, and evaluating learning and achievement goals. According to Zimmerman's model (2000), self-regulation involves three cyclical phases: forethought (setting goals and

planning how to reach those goals strategically), performance/volitional control (implementing plans and metacognitively monitoring implementation efforts), and self-reflection (evaluating goal progress and reflecting on successes and failures which can inform future goal-setting, planning and implementation). To illustrate, consider the following scenario of a student cycling through the three self-regulatory phases in Zimmerman's model. During the forethought phase, a student sets a goal to get an A on an upcoming math test and creates a strategic plan to study 3 hours a day for 2 weeks in order to reach that goal. During the performance/volitional phase, the student implements the plan and, through monitoring, realizes that the plan needs to be modified because 3 hours a day is not enough time to study all of the material. Despite modifying the plan, the student gets a B. In the self-reflection phase, the student considers issues that led to falling short of getting an A and realizes that not visiting the professor during office hours was a mistake. The student then uses this feedback when creating a study plan for the next exam by allowing for more study time and setting up an appointment with the professor. This last part of the scenario illustrates the cyclical nature of the model because what was learned in the self-reflection phase was used to inform the forethought phase for the next exam.

Pintrich (2000, 2004) elaborated on Zimmerman's (2000) model by proposing that four areas could be regulated during each self-regulatory phase: cognition, motivation/affect, behavior, and context. Pintrich also divided Zimmerman's performance/volitional control phase into two different phases ("monitoring" and "control"). Monitoring refers to metacognitive monitoring during goal pursuit and control

refers to volitional processes used to muster motivation during goal pursuit. In addition he changed the names of the other two phases slightly (forethought became "forethought, planning, and activation" and self-reflection became "reaction and reflection"). Pintrich (2000, 2004) used a four by four matrix to portray his model. In the columns were the four areas that can be regulated: 1) cognition; 2) motivation/affect; 3) behavior; and 4) context. And, displayed in the rows were the four self-regulatory phases: 1) forethought, planning, and activation; 2) monitoring; 3) control; and 4) reaction and reflection. While research has yet to systematically investigate these various cells, examples can be provided to illustrate possible scenarios. For example, students could regulate their cognition during the forethought phase by selecting specific learning strategies to use in order to reach their learning goal. In addition, students could regulate their motivation/affect during the control phase by activating their self-efficacy beliefs to instill confidence in themselves that they can accomplish their goal.

Pintrich's (2000, 2004) model provides researchers with a broad theoretical framework for organizing self-regulatory process and outcome variables. This dissertation study fits within that framework and is more narrowly focused on the self-regulation of motivation and behavior through self-regulatory processes related to goal setting, self-evaluation, and value reappraisal.

Research Supporting Self-regulation Theory and Practice

Theory and research on self-regulation has suggested that students can actively construct learning and achievement goals and regulate their own thoughts, emotions, motivations, and behaviors in pursuit of those goals (Boekaerts, Renninger, Sigel,

Damon, & Lerner, 2006; Corno, 1993; Pintrich, 2000, 2004; Pintrich & Degroot, 1990; Wolters, 1998, 2003; Zimmerman, 1989, 2000). The capacity to self-regulate has been found to help students reach their goals, achieve at higher levels, and become more interested in and dedicated to learning and self-improvement (Clearly & Zimmerman, 2001; Lynch, 2006; Metallidou & Vlachou, 2007; Pintrich & Degroot, 1990; Zimmerman, Bandura, & Martinez-Pons, 1992). Contemporary cognitive and motivational views within educational psychology have focused on understanding and fostering strategic and self-regulated learning (e.g., Pintrich, 2000, 2004; Schunk & Zimmerman, 1998, 2007; Weinstein & Mayer, 1986; Weinstein, Husman, & Dierking, 2000). A growing body of evidence suggests that training students to become more self-regulated can improve their use of strategic approaches, their motivation and their performance across subject areas (e.g., math and writing) and educational levels (e.g., elementary and post-secondary) (De Corte, Verschaffel, & Masui, 2004; Fuchs, et al., 2003; Glaser & Brunstein, 2007; Kramarski & Gutman, 2006; Schunk, & Ertmer, 2000; Torrance, Fidalgo, & Garcia, 2007). For example, in a study with ninth grade Israeli students studying linear mathematical functions in an e-learning environment, Kramarski and Gutman (2006) found that adding a self-regulation component to the e-learning environment resulted in higher during and transfer scores on math explanation tasks compared to students in an e-learning only control group.

Self-regulation of Motivation

The self-regulation of motivation concerns students' activation of or strategic control over motivational values, beliefs, and goals such as expectation beliefs, value

perceptions, goal orientations, and attribution beliefs. Regulation of these variables is thought to be directly related to changes in students' choices, effort, and persistence. Volitional researchers were pioneers of the study of the self-regulation of motivation. Theory and research on volition (Corno, 1993; Kuhl, 1985) has suggested that students use strategies to muster the motivation to stay on track in the face of competing alternatives when pursuing a goal. For example, in order to help themselves persist on a homework assignment, students may permit themselves to watch a movie only after they finish their homework (essentially enhancing the value of completing the task by linking it to the desired outcome of watching a movie). Volitional researchers have focused on strategies students can use during the performance/volitional control phase of self-regulation (i.e., while pursuing a goal). However, more recently researchers have suggested that motivation can be regulated during any self-regulatory phase (Pintrich, 2000, 2004; Wolters, 1998, 2003). Wolters and Rosenthal (2000) consolidated research on the regulation of motivation by proposing five motivation regulation strategies (self-consequating, environmental control, interest enhancement, performance self-talk, and mastery self-talk) that seemed to capture much of the work in that area. Wolters (2003) later expanded this list of motivation regulation strategies to include self-handicapping, attribution control, proximal goal setting, efficacy management, and emotion regulation and overviewed research supporting their relationships with motivation. A review of all this research is beyond the scope of this dissertation. However, it is important to place the focus of this dissertation within this larger framework. A major purpose of this dissertation study was to expand research on the self-regulation of motivation by

investigating strategies that can lead to the modification of students' expectation beliefs, value perceptions, task performance, and continued interest.

Self-regulation of Self-efficacy Beliefs and Task Performance

An extensive amount of research has focused on strategies teachers and students can use to increase self-efficacy beliefs (Bandura, 1997; Schunk, 1991; Schunk, & Ertmer, 2000). Some of the strategies that have been suggested include: goal setting, providing feedback and/or rewards, self-instruction for verbalization of strategies, participant modeling, verbal persuasion, and various combinations of these strategies (Alderman, 1999). In a review of research on motivation regulation, Wolters (2003) addressed three strategies that research has shown to be related to the self-regulation of students' self-efficacy: proximal goal setting, defensive pessimism, and efficacy self-talk. A major focus of this review is on the regulation of students' self-efficacy and task performance through goal setting and self-evaluation.

Goal Setting

Goal setting is the process of setting "…quantitative or qualitative standards of performance" (Pintrich & Schunk, 2002). Setting goals is important because goals serve a motivational function. Students with a goal are apt to make choices, expend effort, and persist on activities that they think will help them attain their goal. However the motivational and performance benefits of goals depend on goal difficulty, specificity, and proximity (Locke & Latham, 1990, 2002).

Goal setting has been a major focus within self-regulation interventions. Over forty years of empirical research on goal setting in laboratory, educational, and

work/occupational settings has suggested that setting goals that are moderately difficult and specific leads to higher motivation (e.g., effort and persistence) and performance than setting goals that do not contain these properties (Gellatly & Meyer, 1992; Kane, Baltes, & Moss, 2001; Locke & Latham, 1990, 2002; Ryan, 1970; Seijts, Meertens, & Kok, 1997; Weise, & Freund, 2005; Wood, Mento, & Locke, 1987). In addition, elaborating distal goals with proximal sub-goals (short-term goals that are instrumental in the attainment of a long-term goal) or process goals (goals focused on methods or strategies that can help one master a concept or skill) has been found to increase self-efficacy, motivation, and performance and is considered to be an important part of goal setting (Bandura, & Schunk, 1981; Kitsantas, Reiser, & Doster, 2004; Latham & Seijts, 1999; Schunk, 1996; Schunk & Ertmer, 1999; Schunk & Swartz, 1993).

The more difficult a goal, the more effort is needed to attain the goal. Students who have difficult goals may allocate more resources towards those goals than students with less difficult goals. Goal difficulty has been found to be positively related to motivation and achievement (Locke & Latham, 1990). In one study, school children were administered either difficult or easy goals for solving division problems in their math class. Students who received difficult goals solved more problems and were more motivated towards the task than students who received easy goals (Schunk, 1983). Recommendations for application have suggested that students should set challenging yet realistic (or moderately difficult) goals (Alderman, 1999; Pintrich & Schunk, 2002).

Unlike general intentions to do one's best, specific goals contain a clear and measurable standard that can be used to determine if a goal has been satisfied (Locke,

Chah, Harrison, & Lustgarten, 1989). Researchers have theorized that when a goal is unclear, it can be difficult to decide the type and amount of effort to expend to achieve the goal (Locke & Latham, 1990) and that evaluating goal progress can be difficult (Bandura, 1997). Experimental studies have found that specific goals lead to higher levels of motivation and performance compared to unspecific "do your best" goals, which seem to have little or no effect (Bandura & Cervone, 1983; Locke & Latham, 2002).

Gollwitzer and his colleagues' research on implementation intentions has suggested that specifying when, where, and how to initiate action towards a goal can lead to the automatic activation of goal-directed behavior when one encounters situations that meet those specifications (Gollwitzer, 1993; Gollwitzer, 1999). Goal intentions take the form: "I intend to reach x." Implementation intentions, on the other hand, take the form: "When situation x occurs, I will enact response y" (Gollwitzer, 1999). A metaanalysis of over 94 independent tests showed that forming implementation intentions had a medium-to-large positive effect (d=.65) on goal attainment across academic, health, educational, and interpersonal domains (Gollwitzer & Sheeran, 2006). For example, in a seminal study Gollwitzer and Brandstatter (1997) asked college students to name two projects (one that was difficult and one that was easy) they intended to complete over winter recess. They also asked students whether or not they formed implementation intentions on when and where they would get started on their winter projects. For the difficult project, of the students who formed implementation intentions two thirds reported completing the project. However, of the students who did not form implementation

intentions, only one fourth reported completing their difficult winter project. For the easy project, forming implementation intentions did not seem to matter.

Proximal goals are temporally close to the present and may help direct students in what to do in the here and now. Distal goals, on the other hand, are placed relatively further away in time and may not direct students in what to do presently, even though they may provide direction in what proximal goals to set (Pintrich & Schunk, 2002). Setting proximal sub-goals (i.e., proximal goals that are designed to enable the attainment of distal goals) has been found to increase motivation and achievement. In one study, students who were identified as having deficits and disinterest in math were assigned to set proximal sub-goals, distal goals, or no goals for solving math problems (Bandura & Schunk, 1981). Increases in task performance, self-efficacy, and intrinsic motivation were observed for students who set proximal sub-goals but not for students in the other two groups. Even though distal goals may not serve to motivate present behavior, they might be important for long-term planning and having a sense of what one is working towards (Nuttin & Lens, 1985).

Process goals refer to goals focused on methods or strategies that can help one learn a concept or attain a skill. Process goals can be thought of as a special type of proximal, sub-goal because process goals tend to be temporally close to the present and enable the attainment of longer-term goals. Research on process goals have often compared them to product goals which are goals focused on reaching an outcome. Theoretically, process goals are thought to be beneficial because they can focus students on figuring out critical methods and strategies involved in mastering a task (Schunk,

1996; Schunk & Ertmer, 1999). Process and product goal manipulations have often been very superficial but also very powerful. For example, in two studies with fourth-graders, Schunk (1996) had teachers prompt students before the beginning of math lessons on fractions with either a process goal ("You'll be trying to learn how to solve fraction problems…") or a product goal ("You'll be trying to solve fraction problems…"). They also had students repeat the goals they were prompted with. The manipulation was only different in that the process goal manipulation contained the words "learn how to." Schunk (1996) found that students who received process goals had higher self-efficacy and task performance scores for solving fraction problems than students who received product goals.

In sum, increasing self-efficacy and task performance has been shown to be facilitated by five goal setting strategies: 1) setting challenging yet realistic goals; 2) setting clear and measurable goals; 3) elaborating goals with implementation intentions that specify when, where, and how to initiate action towards a goal; 4) setting proximal sub-goals to enable the attainment of distal goals; and 5) setting process goals that are focused on methods and strategies that can be used to learn course content and master course skills.

Self-Evaluation

While goal setting is a crucial aspect of self-regulation, evaluating the progress that is made towards reaching a goal (i.e., self-evaluation) is also important because doing so can provide students with feedback on their goal attainment that can help them modify, if necessary, their strategic approaches (Clearly & Zimmerman, 2001; Kitsantas

& Zimmerman, 1998). Getting feedback on goal progress (whether through self-evaluation or from teacher-feedback) has been found to positively impact task performance and self-efficacy (Bandura & Cervone, 1983; Kitsantas, Reiser, & Doster, 2004; Schunk, 1983, 1996; Schunk & Swartz, 1993). Social-cognitive theory suggests that when students notice that they are making progress toward their goals, they are likely to become more confident in their abilities to reach those goals that can, in turn, sustain their motivation and make goal achievement more likely (Schunk, 1996).

Interaction of Goals and Self-Evaluation

Research has also investigated the interaction between goals and self-evaluation (Kitsantas, Reiser, & Doster, 2004; Schunk, 1996). For example, Schunk and Ertmer (1999) examined the main and interactive effects of goal (college students were either assigned a process or product goal) and self-evaluation (they were either asked to self-evaluate goal progress or not) in an introductory course on computers in education. Results supported main effects of both goal and self-evaluation on self-efficacy and task performance but no interactions were found. Self-evaluating goal progress contributed to increases in self-efficacy for completing a specific course assignment as did being given a process goal. Goal setting and self-evaluation are thus two self-regulatory strategies that have been found to positively influence students' self-efficacy beliefs and task performance.

Intervention research on goal setting and self-evaluation in educational settings has largely focused on embedding self-regulatory prompts within teacher instructions and academic tasks in order to prompt students to adopt goals and self-evaluate their goal

progress. Much less intervention research has guided students in writing out goals for themselves and keeping track of their goal progress outside of class. Furthermore, a search of research literature on goal setting and self-evaluation interventions did not yield any interventions specific to the area of introductory statistics courses.

In my master's thesis (Acee, 2007), I drew on literature from goal setting and self-evaluation to inform the development of the Goal Setting Intervention (GS), a computerized intervention aimed at helping students succeed in their statistics courses. The intervention instructed students in setting two distal course goals and two proximal sub-goals for each distal goal. In addition, students were instructed in revising their goals so that they were challenging yet realistic, specific and measurable, and contained a start- and end-date. They also created goal attainment scales for their goals (i.e., a student-created, five-point rating scale that indicates what it means to: fall short of the goal by a lot, fall short of the goal by a little, meet the goal, exceed the goal by a little, and exceed the goal by a lot) (Kiresuk, Smith, & Cardillo, 1994). After 2 weeks, students self-evaluated the progress that they made towards each of their goals. It was hypothesized that GS would positively impact students' self-efficacy and exam performance but not necessarily impact students' value perceptions or choice-behaviors to engage in learning statistics beyond what was required in the course. Results suggested that GS had no effects on any of the outcomes (Acee, 2007).

One reason why there were no GS effects could be because students tended to report falling short of reaching the goals they set as part of the intervention. Social cognitive theory suggests that increases in self-efficacy tend to be found when students

observe themselves succeeding and may remain neutral when they fall short of their goals (Schunk, 1996). Furthermore because GS was focused on helping students set goals for the course in general as opposed to a specific academic task, its effect may have been too diffuse to detect. Focusing the Goal Setting Intervention on a specific task, like an upcoming exam, might concentrate intervention effects and make them easier to detect. In addition, requiring more frequent self-evaluation could help to increase the effectiveness of the intervention (Schunk & Ertmer, 1999).

In this dissertation study, the Enhanced Goal Setting Intervention (GS-E) that I developed had a more specific focus than GS. GS was focused on helping students set course goals in general. They were instructed to set two long-term goals (that could be focused on anything related to their statistics course) and four proximal sub-goals that could help them reach those long-term goals. GS-E, on the other hand, focused on helping students set goals for reaching two learning objectives for the next exam in their statistics course. For each learning objective, students were instructed to set four proximal process goals (eight goals total) focused on methods and strategies they could use to reach each learning objective. Another major difference between GS and GS-E was the number of times students were asked to self-evaluate their goal progress (one vs. four times, respectively). Furthermore, the self-evaluation component of GS-E asked students to consider how they could improve their approaches to reaching each learning objective (this part of the self-evaluation activity was not included in GS). GS-E also contained an opening section that was not present in GS. This opening section guided students in describing and reflecting about effective and ineffective goal setting for their

statistics course. Similar to GS, GS-E asked students to revise their goals so that they are challenging yet realistic, specific and measurable, and specify when they would work on their goals.

In sum, GS-E was derived from research on goal difficulty, goal specificity, implementation intentions, goal proximity, process goals, and self-evaluation; and was focused specifically on helping students to reach two learning objectives for their next statistics exam. By making progress towards their goals and reaching their learning objectives, students might increase their confidence in their capabilities to perform tasks in their statistics course and become better prepared for their next statistics exam. Accordingly, GS-E was hypothesized to positively impact students' self-efficacy and exam performance in their statistics course.

Self-regulation of Value Perceptions and Continued Interest

While a considerable amount of theory and research exists on how to help students increase their self-efficacy beliefs and achievement, there is currently not much theory or research focused on how to help students positively reappraise the value of learning in a particular subject area (value reappraisal) (Brophy, 1999; Pintrich, 2000, 2004; Wolters, 1998, 2003). For this study, I developed a conceptual model of value reappraisal. This theory combines disparate research conducted by educational psychologists and social psychologists in the areas of persuasion, expectancy-value, and self-regulation theories. The basic premise of this Value Reappraisal Theory (VRT) draws on what was proposed by persuasion and attitude change researchers over 40 years ago.

Value Reappraisal Theory

Rooted in information processing theory, models of persuasion (Petty & Cacioppo, 1986), attitude change (Greenwald, 1968), and conceptual change (e.g., Dole & Sinatra, 1998) share a basic framework that is useful for understanding the modification of students' value perceptions about academic tasks and courses. This framework suggests that processing or elaboration of a message increases the potential for attitude change. Processing a message favorably increases the potential for attitude change in the direction advocated in the message; processing a message unfavorably increases the potential for attitude change in the opposite direction from what was advocated in the message (Bohner & Schwarz, 2001; Greenwald, 1968; Petty, Ostrom, & Brock, 1981). The effect of a persuasive message on a students' attitude is, therefore, believed to be mediated by the students' cognitive responses to the message. This indicates that presenting students with messages about why a task may be valuable and then guiding them in processing these messages favorably could help them to positively reappraise the value of the task.

However, research in this area has primarily focused on the persuasive aspects of the message (e.g., credibility of the author, strength of arguments, ease of understanding text, balanced arguments, emotion provoking, interesting text) and personal characteristics of the participants (e.g., pre-existing beliefs and values, level of prior knowledge about the message topic, and motivation to process the message) and how those variables interact to predict students' cognitive responses to a message and hence their change in attitude (see Bohner & Schwarz, 2001). Instead of relying on the

messages alone to produce attitude change, activities could be used to guide students in using strategies to process the messages. Not much research has investigated interventions that both present students with messages and guide them in using strategies to explore issues related to those messages. The basic idea behind value reappraisal theory is that students' value perceptions about academic tasks, courses, and subject areas can be modified by presenting them with messages about why learning in those areas might be important for them and guiding them in using strategies to further process and explore the value of learning in those areas for them personally.

Persuasive Messages

Providing students with messages about the different reasons why an academic task might be valuable has been suggested as one approach that could help students to positively reappraise the value of a task (Brophy, 1999; Hofer, 2002). For example, in a study on goal and implementation intentions Dholakia and Bagozzi (2003) found that students had stronger commitments and were more likely to access extra not-for-credit reading assignments when they received a message about the importance of the reading (i.e., the goal intention manipulation) compared to students who received no such message. Similarly, providing a rationale when assigning a task, as opposed to assigning it tersely, has been found to lead to relatively higher motivation and performance in work/occupational settings (Latham, Erez, and Locke, 1988). However, what content should the message convey to students in order to convince them that it is important?

Current conceptualizations of task value put forth by Eccles and Wigfield postulate that students might value a task for different reasons and their framework could

be used to help explain to students the potential value of a task. For example, a student may value a task because it is generally important and in line with their self-concept (attainment value), useful for achieving their future goals (utility value), or enjoyable in and of itself (intrinsic value) (Eccles, 2005; Eccles, et al., 1983; Wigfield & Eccles, 1992, 2000, 2002). In addition, the cost of task engagement (e.g., time, effort, and negative emotions) is another type of value perception that could be addressed (Eccles, et al., 1983). In Dholakia and Bagozzi's (2003) study described above, they also manipulated perceived task difficulty by providing students one of two messages about the amount of time and effort that would be involved in accessing the extra not-for-credit reading assignment. They found that students in the high-difficulty condition were less likely to access the reading than students in the low-difficulty condition. While providing students with messages about why a task may be important and the costs associated with task engagement could be instrumental in helping students positively reappraise the value of a task, reappraising a task's value may also involve the active use of strategies, and interventions could guide students in using such strategies.

Value Reappraisal Strategies

Wolters (1998) found that students reported using strategies to enhance task value in order to increase their motivation; especially in situations where they initially appraised the material as irrelevant. Students reported strategies such as trying to make the task personally relevant, finding ways that the task could be useful in future situations, and trying to make the task more enjoyable. Helping students actively

brainstorm different reasons and generate rationales for course engagement might help students to modify their course-related value perceptions and continued interest.

Using imagination and mental simulation (Markus & Nurius, 1986; Pham & Taylor, 1999; Singer, 1975) to explore the value of learning (e.g., imagining experiencing positive incentives associated with task success) might also be an important strategy involved in generating value perceptions. Singer (1975) showed that most all humans daydream and use imaginative processes to elaborate thoughts and ideas and that these processes are instrumental in linking cognition, emotion, and motivation. Markus & Nurius (1986) suggested that imaginative processes are also involved in the elaboration of future possible selves, which are schemata that serve to motivate people towards the futures that they envision for themselves. In addition, contrasting future benefits of learning with costs of task engagement (Oettingen, Pak, & Schnetter, 2001) has been found to help students increase their commitments to learning course material. Oettingen and her colleagues conducted a series of studies across various domains (e.g., academic, interpersonal) and found that contrasting future benefits with realistic costs of a task resulted in higher task commitment and performance compared to when they were asked to only imagine future benefits or only realistic costs. Based on disparate theory and research, brainstorming, generating rationales, imagining, and contrasting the pros and cons of the importance of academic tasks, courses, and subject areas could help students to modify their value perceptions about those tasks, courses, and subject areas.

In my master's thesis (Acee, 2007), I used theory and research on the self-regulation of value perceptions to inform the development of a computerized intervention

designed to help students increase the value they place on learning statistics. Students were presented with persuasive messages about why statistics was important and guided in using value reappraisal strategies to process those messages. Students were presented with messages about everyday and professional uses of statistics (utility value), the need to be an intelligent consumer of statistics in everyday life (attainment value), and the intrinsic enjoyment of learning statistics (intrinsic value). Students were also guided in using value reappraisal strategies to process the content of these messages by brainstorming, generating rationales, generating mental simulations and contrasting pros and cons related to the importance of learning statistics. It was hypothesized that the Value Reappraisal Intervention (VR) would positively impact students' value perceptions and a choice-behavioral measure of continued interest in statistics but not necessarily lead to changes in self-efficacy or exam performance. The results suggested strong positive effects on students' overall task value, endogenous utility value and the choice-behavioral measure of continued interest in statistics (Acee, 2007). Intervention effects on intrinsic value and exogenous utility value were small to medium but were not significant. Understanding the mechanisms within VR that contributed to students' positive reappraisal of learning statistics is important both theoretically and practically. The content of the persuasive messages is one aspect of the intervention that could have contributed to student gains. The various value reappraisal strategies that were used could have also helped students' place more importance on learning statistics. The main and interactive effects of these variables need to be studied in future research. In addition, personal characteristics of the learner need to be examined.

The value reappraisal intervention tested in this dissertation study had the same focus, components, and flow as the one tested in my master's research. However, several revisions were made. First, minor revisions were made to the wording of the intervention so that it was more clear and comprehensible to the average college student. Second, in my master's research the opening section of the intervention was on the importance of developing a positive attitude for college courses in general. In my dissertation study, this section was revised to focus on students' introductory statistics course, not college courses in general. Third, in the section on intrinsic value, three additional examples were provided and an additional step to an activity was included in order to strengthen that section. Three examples of ways students can increase their intrinsic value for a task were added: making studying into a game, applying statistics to everyday life, and applying statistics to personal questions about society and the world. In addition, one activity was added that has students choose two strategies they could use to increase their intrinsic value for statistics. Because of these revisions and enhancements, the value reappraisal intervention tested in this dissertation was called the Enhanced Value Reappraisal Intervention (VR-E).

The purpose of this dissertation was to test the differential effects of the Enhanced Goal Setting Intervention (GS-E) and the Enhanced Value Reappraisal Intervention (VR-E) on students' self-efficacy beliefs, value perceptions, exam performance and continued interest in statistics. A Control Condition (C) was also included (students completed three Texas Information Literacy Tutorial modules and answered reflective questions about what they learned). It was hypothesized that GS-E and VR-E would differentially affect

the study outcomes. Students who received GS-E were hypothesized to make significant gains on self-efficacy beliefs and exam performance, whereas, students who received VR-E were hypothesized to make significant gains on value perceptions and continued interest in statistics.

This literature review overviewed research on expectancy-value theories and self-regulation theories and integrated them by focusing on the self-regulation of motivation. Particular emphasis was given to the self-regulation of self-efficacy beliefs and value perceptions. The section on the self-regulation of self-efficacy beliefs and task performance concerned strategies related to goal setting and self-evaluation. Issues related to distal vs. proximal sub-goals, process goals vs. outcome goals, and goal specificity and difficulty were addressed. In addition social-cognitive theory was used to explain how goal setting and self-evaluation can lead to increases in self-efficacy when students receive positive feedback on their goals. The section on the self-regulation of value perceptions and continued interest I developed a conceptual model of value reappraisal which focused on two major factors that are thought to influence the modification of students' value perceptions: persuasive messages and value reappraisal strategies. Particular emphasis was given to the content of persuasive messages (presenting messages about the attainment, utility, and intrinsic value of a task) and value reappraisal strategies (brainstorming, generating rationales, imagining, and contrasting pros and cons related to why a task may be valuable). Research on the self-regulation of motivation in educational settings is incipient and this literature review helps to integrate

disparate research on the subject and generate hypotheses about the differential relationships of self-regulatory processes with motivation and achievement outcomes.

Motivation and Achievement in Undergraduate Statistics

Undergraduate introductory statistics courses were chosen as the context for this study because students often evidence negative motivational values and beliefs for learning statistics and statistics educators consider these variables to be important educational outcomes (Fullerton & Umphrey, 2001; Gal, Ginsburgh, & Schau, 1997; Garfield, Hogg, Schau, & Whittinghill, 2002; Mills, 2004). In addition, students' values and beliefs towards learning statistics have been found to be positively related to learning and achievement in statistics courses (Bandalos, Finney, & Geske, 2003; Cashin & Elmore, 2005; Finney & Schraw, 2003; Schutz, Drogosz, White, & DiStefano, 1998; Tremblay, Gardner, & Heipel, 2000). Furthermore, many undergraduate programs within the United States require successful completion of an introductory statistics course for graduation or entry into an upper division major and the number of students taking introductory undergraduate statistics courses has been reported to be increasing (Loftsgaarden & Watkins, 1998). Helping students set and evaluate course goals and reappraise the material as being important to learn and understand could potentially help students improve their expectation beliefs and value perceptions and achieve at higher levels. A review of the literature yielded no research that has systematically investigated interventions that target improving students' motivational values and beliefs in undergraduate statistics courses.

Sex Differences in Math- and Science-Based Courses

Women were chosen as the focus of this study to help address the growing social and economic needs to generate effective interventions that can help underrepresented minorities to build their confidence, develop a continued interest and increase their success in math and science education (National Science Foundation, 2006; U.S. Department of Education, 2006). Research on sex differences in math and science typically suggest that women have lower confidence and less interest in those subjects compared to men (see Wigfield & Eccles, 2002), despite trends that achievement differences in these areas are diminishing (Eisenberg, Martin, & Fabes, 1996; Marsh, 1989). For example, in a study on undergraduates enrolled in an introductory statistics course, Mills (2004) found that women reported lower confidence and higher anxiety related to statistics compared to men. A metaanalysis of research on achievement in undergraduate applied and introductory statistics courses revealed small sex differences in favor of women (d=.08). However further analyses showed that in studies where the outcome measures were a series of exams, men outperformed women; but, the reverse was true when the outcomes were course grades or points.

Sex differences and sex by treatment interactions were not tested in this dissertation study. The statistics course being used in this study had a small number of men who enrolled (approximately 18%) – too few to merit including sex as a variable in analyses. Therefore, including men could introduce unexplained variation and potentially bias results.

Chapter 3

Methods

The Proposed Causal Model

The major goal of this research was to examine the differential effects of the Enhanced Goal Setting Intervention (GS-E), Enhanced Value Reappraisal Intervention (VR-E), and Control Condition (C), on undergraduate, introductory statistics students' self-efficacy beliefs, value perceptions, exam performance and continued interest in statistics. As described in the previous chapter, research has found that goal setting and self-evaluation are two self-regulatory strategies that can be used to increase students' self-efficacy and task performance. Drawing on this research, GS-E was designed to help students set goals for their statistics course and self-evaluate the progress made towards these goals over 2 weeks. While much less research has been conducted on the modification of students' value perceptions, some evidence has suggested that persuasive messages and value reappraisal strategies can be used to positively impact students' value perceptions and continued interest in a subject area. Accordingly, VR-E presented students with persuasive messages about why learning the content of their introductory statistics course is important and guided them in using value reappraisal strategies to explore the importance of learning statistics.

The causal model tested in this dissertation (see Figure 1 in the Introduction) suggests differential effects of the interventions on the study outcomes. GS-E was hypothesized to positively impact students' self-efficacy and exam performance, while

VR-E was hypothesized to positively impact students' value perceptions and continued interest in statistics. C was hypothesized to have no impact on any of the outcomes.

Research Questions and Hypotheses

The causal model shown in Figure 1 is a simple way to depict the hypotheses of this dissertation study. Presented below are research questions, hypotheses, and rationales for each dependent variable.

Research question 1

How did the Enhanced Goal-setting Intervention (GS-E) impact the outcome variables of interest in this study?

Hypothesis 1(a)

On average, students who received GS-E were hypothesized to make greater increases on all three measures of self-efficacy (self-efficacy for course tasks, self-efficacy for exam performance, and self-efficacy for reaching learning objectives) over time (pre-test to immediate post-test and pre-test to 2-week delayed post-test) compared to students who received VR-E or C. No specific hypotheses were made for changes in self-efficacy from immediate post-test to 2-week delayed post-test because the size of the effect from pre-test to immediate post-test and from pre-test to 2-week delayed post-test was unable to be determined a priori.

Hypothesis 1(b)

On average, students who received GS-E were hypothesized to have higher post-intervention exam scores, after controlling for pre-intervention exam scores, compared to students who received VR-E or C.

Rationale

Goal-setting and self-evaluation are two self-regulatory strategies that have been found to lead to increases in self-efficacy and performance. In my master's research (Acee, 2007), GS contained goal setting and self-evaluation components but was not found to impact self-efficacy and exam performance. GS-E was a modified and enhanced version of GS which had students set and evaluate eight proximal process goals for reaching two learning objectives for their upcoming exam (see the Methods section for more details). Because GS-E contained goal setting and self-evaluation components and because it was modified and enhanced to be more powerful than GS, it was hypothesized that GS-E would positively impact self-efficacy and exam performance. GS-E was hypothesized to increase students' self-efficacy beliefs from pre-test to immediate post-test because theory and research have suggested that merely setting goals can have immediate positive effects on students' self-efficacy beliefs (Gollwitzer, 1999; Pintrich & Schunk, 2002). GS-E was also hypothesized to positively impact self-efficacy from pre-test to 2-week delayed post-test because research has also found delayed effects of goal setting and self-evaluation on self-efficacy. Social-cognitive theory suggests that goal setting and self-evaluation can help students reach their goals and improve their capabilities to complete course-related tasks. When students notice themselves making progress towards their goals, their self-efficacy is thought to be substantiated. However, failing to reach a goal is not believed to lower self-efficacy. No specific hypotheses were made for changes in self-efficacy from immediate post-test to 2-week delayed post-test

because the size of the effect from pre-test to immediate post-test and from pre-test to 2-week delayed post-test were unable to be determined a priori.

Research question 2

How did the Enhanced Value Reappraisal Intervention (VR-E) impact the outcome variables of interest in this study?

Hypothesis 2(a)

On average, students who received VR-E were hypothesized to report greater increases on all four measures of value perceptions (overall task value, endogenous utility value, exogenous utility value, and intrinsic value) over time (pre-test to immediate post-test and pre-test to 2-week delayed post-test) compared to students who received GS or C. No specific hypotheses were made for changes in value perceptions from immediate post-test to 2-week delayed post-test because past research on VR was inconsistent. In both Study 1 and Study 2 of my master's thesis (Acee, 2007), the VR Group's value perceptions increased from pre-test to immediate post-test. However from immediate post-test to 2-week delayed post-test, the VR Group's value perceptions decreased moderately in Study 1 and did not increase or decrease in Study 2.

Hypothesis 2(b)

On average, students who received VR-E were hypothesized to report greater increases on the self-report measure of intentions to continue learning statistics over time (pre-test to immediate post-test and pre-test to 2-week delayed post-test) compared to students who received GS or C. No specific hypotheses were made for changes in self-

report measures of continued interest from immediate post-test to 2-week delayed post-test because past research on the effect of VR on value perceptions was inconsistent.

Hypothesis 2(c)

On average, students who received VR-E were hypothesized to score higher on the choice-behavior measure of continued interest in statistics compared to students who received GS or C.

Rationale

VR-E was designed to help students positively reappraise the value of their statistics course by exposing them to persuasive messages and guiding them in using value reappraisal strategies. VR-E addressed the four components of the value construct described in the literature review above (i.e., attainment, utility, intrinsic, and cost) and guided students in using value reappraisal strategies related to brainstorming, generating rationales, imagining, and contrasting pros and cons related to why statistics is important for them personally. In my master's research (Acee, 2007), VR lead to significant gains on overall task value and endogenous utility value overtime. VR also lead to significant gains on a choice-behavior measure of continued interest in statistics. While the effect of VR on exogenous utility value was not consistent (it did not replicate in Study 2 of my thesis) and non-significant for intrinsic value, the effect sizes were small to moderate and in the expected directions in both studies. This dissertation study had more power to detect significance than my master's thesis results because there was a higher sample size per group (approximately 30 compared to 20). Therefore, because VR-E addressed all value perceptions being measured in this study, and, because this study had more power

to detect intervention effects compared to my master's thesis, it was hypothesized that VR-E would positively impact students' ratings on all measures of value perceptions and continued interest in statistics used in this study. The effect of VR-E on value perceptions was hypothesized to be observed from pre-test to immediate post-test and pre-test to 2-week delayed post-test. However, no specific hypotheses were made for immediate post-test to 2-week delayed post-test. In my master's research a positive effect of VR on students' value perceptions was found from pre-test to immediate post-test and pre-test to 2-week delayed post-test. However, changes from immediate post-test to 2-week delayed post-test were inconsistent for students who received VR. In Study 1, value perceptions decreased moderately but not back to where they were at pre-test and in Study 2 value perceptions did not increase or decrease.

Participants

The selection criteria used for this study were: 1) female; 2) undergraduate; and 3) enrolled in either Section A or Section B of an Introduction to Statistics course. Women were selected because researchers typically report that women have lower confidence and less interest in math- and science-based subjects (Wigfield & Eccles, 2002) and may, therefore, have a greater need to improve in these areas. Furthermore, too few male students (18% based on data from the EDP subject pool website) enroll in the course to have included sex as a variable in the analyses. Including men could introduce unexplained variation and potentially bias results. Undergraduate students, who make up approximately 93% of those enrolled in Introduction to Statistics, were selected because graduate students might have different reasons and motivations for wanting to learn

statistics than undergraduate students. Including graduate student data could introduce unexplained variance to the analyses and make the generalizability of findings to undergraduate students questionable.

All female undergraduate students enrolled in Sections A and B of an Introduction to Statistics course offered through the Department of Educational Psychology at a large university in the Southwest United States were requested through the human subject pool during the Fall, 2008 semester. Of the 101 students that were assigned to this study, 13 were not included in the final dataset for the following reasons: 8 students were graduate students (one of whom was male) and, therefore, did not meet the selection criteria; 2 students did not come to any of the study sessions; and 3 students did not complete the 2-week delayed post-test measures. Thus, the final dataset contained a total of 88 students with complete data on all of the outcomes measures. The sample size for this study was only two participants larger than what was estimated a priori.

The ethnic composition of this sample of female undergraduates was as follows: African American (n=11); Asian (n=17); Caucasian (n=42); Hispanic (n=17) and, both Caucasian and Hispanic (n=1). There were no first-year students in this sample and data on students' year in school was as follows: sophomore (n=19); junior (n=42); and senior (n=27). The sample had an average age of 20.51 (*SD*=1.57) and students' ages ranged from 18 to 30. Most all students were United States citizen (n=86).

Students were enrolled in various colleges and programs across campus and intended to seek degrees in the following areas: Advertising (n=2); Applied Learning and Development (n=1); Biology (n=11); Chemistry (n=1); Communication Sciences and

Disorders (n=4); Communication Studies (n=2); Human Development and Family Sciences (n=17); Human Ecology (n=3); Kinesiology (n=5); Mathematics (n=2); Music Performance (n=1); Nursing (n=13); Nutrition (n=16); Philosophy (n=1); Psychology (n=1); Public Relations (n=2); Textiles and Apparel (n=5); and undecided (n=1). Furthermore, most students had already declared a major (n=84).

Students were sampled from two course sections: Section A (n=58) and Section B (n=38). Each section had a different instructor. There was a third section of the course that was not sampled from because an exam was to be given in that section during the time period when the study was to be run. This was deemed problematic because some students would have received the intervention prior to the exam and others would have received it afterwards. The two sections that were sampled from had exams before the study began and approximately 1 month after the study was completed.

Design

The major purpose of this experimental study was to investigate the differential effects of a goal setting and a value reappraisal intervention on college students' self-efficacy, task values, exam performance, and continued interest in statistics. Participants were stratified on course section and year in school and randomly assigned to one of three conditions: Control (n=30), GS-E (n=27), and VR-E (n=31). The sample size is not perfectly even among groups because of five participants who were randomly assigned to groups but were then later removed because they had incomplete data (four were assigned to the GS-E Group and one was assigned to the Control Group.

The repeated measures design included a pre-test, immediate post-test, and 2-week delayed post-test for self-reported measures of self-efficacy (self-efficacy for course tasks, self-efficacy for exam performance, and self-efficacy for reaching learning objectives), value perceptions (overall task value, endogenous utility value, exogenous utility value, and intrinsic value), and continued interest in statistics (intentions to continue learning statistics). For students who received GS-E, goal progress data was collected approximately 3, 7, 10, and 14 days after receiving the intervention. With students' consent, their exam scores and total course score were collected from their instructors' files. The first exam given after the administration of the intervention was used as a dependent measure (approximately 4-5 weeks for Course Section A and approximately 6-7 weeks for Course Section B). A choice-behavior measure of continued interest in statistics was implemented by posting statistics websites on the course website and tracking who accessed those websites. The statistics websites were posted approximately 6 to 7 weeks after the administration of the intervention/control condition. See Table 1 for a description and the sequence of study procedures.

Dependent Variables

All self-report measures used a 7-point Likert-type scale (1 "Strongly Disagree," 2 "Disagree," 3 "Disagree a Little," 4 "Undecided," 5 "Agree a Little," 6 "Agree," 7 "Strongly Agree)" unless otherwise specified. All self-report measures referred to students' statistics course except intentions to continue learning statistics which referred to statistics in general. Measures were administered online using Survey Monkey. See Appendix A for the items on each scale. There were a total of 45 self-report items.

Self-efficacy

Self-efficacy for Course Tasks (SECT). Students' self-efficacy for course tasks was measured with The Perceived Academic Competence Scale (PACS) (example item: "I can do almost all the work in this course if I don't give up"). This measure targets a variety of course tasks and is not specific to any one task. PACS items refer to students' confidence in their capabilities to succeed at the work in a course, mastering course skills, learning course content, and performing well on assignments and tests. PACS was developed by Kaplan and Midgley (1997) by selecting seven items from the Academic Self-Beliefs Scale of Midgley, Maehr, and Urdan's (1993) Patterns of Adaptive Learning Survey. Kaplan and Midgley (1997) reported strong reliability coefficients when used in both seventh grade English ($\alpha = .83$) and Math ($\alpha = .85$) classes.

Furthermore, items for the PACS loaded as expected in a factor analysis that used oblique rotation and included learning and performance goal orientation items. In my master's thesis (Acee, 2007) I modified the PACS to refer to students' statistics course, and strong reliability coefficients were obtained ($\alpha = .88$ in Study 1, $\alpha = .91$ in Study 2). For the purposes of this dissertation, the items will again be adapted to refer to students' EDP371 statistics course. Also because one item was double-barreled and referred to "assignments and tests", this item was divided into two separate items - one referring to assignments and the other to tests. Thus, the measure used in this study had eight items, not seven.

Self-efficacy for Exam Performance (SEEP). Students were instructed: "Please indicate the highest percentage score you feel completely certain (100% sure) you can

achieve on the next exam in your EDP371 course. Type your response (from 0 to 100) in the box below." This single item was used to measure students' self-efficacy for their post-intervention statistics exam. The wording of this item was derived from an unpublished questionnaire I obtained from Jenefer Husman (personal correspondence, 2008).

Self-efficacy for Reaching Learning Objectives (SERLO). Students were instructed: "Please indicate the highest percent of learning objectives for your next EDP371 exam you feel completely certain (100% sure) you can reach before taking the exam. Type your response (from 0 to 100) in the box below." This single item was used to measure students' self-efficacy for reaching learning objectives for their post-intervention EDP371 exam. The wording of this item was derived from an unpublished questionnaire I obtained from Jenefer Husman (personal correspondence, 2008).

Value Perceptions

Overall Task Value (OTV). The overall value students' place on course tasks was measured with The Task Value Scale (TVS), a scale from the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, et al., 1991) (example item: "Understanding the subject matter of this course is very important to me"). TVS has a total of six items. Attainment, utility and intrinsic value are each measured by two items. The six items are averaged together to get an overall task value score. TVS has been widely used and high reliability coefficients have been reported ($\alpha = .90$) (Duncan & McKeachie, 2005). In my master's research (Acee, 2007) I used the TVS to measure the overall value students placed on EDP371 tasks and obtained high reliability coefficients ($\alpha = .90$ in Study 1 and

α = .92 in Study 2). It was also found to be sensitive to VR effects at the immediate post-test and 2-week delayed post-test (Acee, 2007).

Endogenous Utility Value (END-UV) and Exogenous Utility Value (EXO-UV). The perceived usefulness of developing knowledge and skills related to a course for the attainment of future goals (endogenous utility value) and the perceived usefulness of performing well in a course for the achievement of future goals (exogenous utility value) were measured with The Perceptions of Instrumentality Scale (PI) (Husman, personal correspondence, 2008). PI was derived from perceptions of instrumentality measures that were used in Husman and colleagues' previous work (Husman, Derryberry, Crowson, & Lomax, 2004; Husman & Hilpert, 2007). PI consists of a total of eight items. Four items are used to measure endogenous utility value (example item: "What I learn in this course will be useful for my future occupational success"). Four items are also used to assess exogenous utility value (example item: "The grade I get in this course will affect my future"). Empirical evidence has suggested that the original four-item measure of endogenous utility value had good reliability (α=.86) (Husman, Derryberry, Crowson, & Lomax, 2004). In addition, factor analytic results from that study suggested the measure of endogenous utility value was distinctive yet somewhat related to the MSLQ measure of task value and intrinsic motivation. In my master's research, I measured endogenous (α = .85 in Study 1 and α = .89 in Study 2) and exogenous utility value (α = .74 in both Study 1 and 2) with a modified version of Husman, Derryberry, Crowson, and Lomax's (2004). Also, these measures were found to be sensitive to VR effects at immediate post-test and 2-week delayed post-test, particularly for endogenous utility value (Acee, 2007).

Intrinsic Value (IV). Intrinsic value (students' interest or enjoyment in a task) was measured with the Interest/Enjoyment Scale (IES) (example item: "This coursework is fun to do"). The IES is one of four dimensions measured by the Intrinsic Motivation Inventory (IMI) (Ryan, 1982). The IES is comprised of seven items. McAuley, Duncan, and Tammen (1989) used the IES to measure college students' interest and enjoyment in playing a basketball game. They reported a reliability coefficient of .78 for the IES. In my master's research (Acee, 2007), I modified the IES to refer to students' EDP371 statistics course and obtained a reliability coefficient of $\alpha = .92$ in Study 1 and $\alpha = .94$ in Study 2. For the purposes of this dissertation study, IES items were again modified to refer to students' EDP371 statistics course.

Continued Interest in Statistics

Intentions to Continue Learning Statistics (ICLS). A revision of Acee's (2008) unpublished ICLS measure was used (example item: "If taking another statistics course was not required, I would still want to take another statistics course"). The original six-item ICLS measure yielded a strong reliability coefficient ($\alpha = .92$) when used with EDP371 students. The ICLS was revised by making three of the items negatively worded and rewording two of the items so that the contextual element of the items preceded the item stem.

Choice-Behaviors to Learn Statistics (CBLS). Acee's (2007) CBLS measure was used to measure students' choice-behaviors to learn statistics. Approximately 6-7 weeks after the administration of the interventions and control condition, two website links related to statistics were posted on the students' EDP371 course website. Website

A (http://www.statsoft.com/textbook/stathome.html) has information on statistical terminology and procedures. Website B (http://www.amstat.org/meetings/jsm/2000/usei/case.html) has information on how statistics are used in a variety of professions. Students were sent the following e-mail from their instructor to prompt them that the website links were available: "Hi Class, A graduate student of mine found two really good internet sites related to statistics. One site has definitions and explanations for statistical terminology and the other has information about why statistics is important and how people use statistics in various occupations. If you have some free time, please check them out. They are interesting." The e-mail also included instructions for how to access the website links from their course website. A statistical tracking mechanism was enabled on the course website that tracked which students accessed the website links through the course website. Whether or not students accessed a website link was used as a choice-behavior measure of students' continued interest in learning statistics. Acee (2007) found that this measure was sensitive to VR intervention effects. It was found that of the 11 students who accessed either website, 10 of them received the VR Intervention (Acee, 2007).

Exam Performance (EP)

The first exam given after the administration of the interventions and control condition was used as a dependent variable. For Section A, the third course exam was used (given approximately 4-5 weeks after the administration of the interventions and control condition). This exam was given during class, was not open-book, and covered

the following topic areas: related samples t test; independent samples t test; correlation; simple linear regression; and Chi-square test of association. For Section B, the second course exam was used (given approximately 6-7 weeks after the administration of the interventions and control condition). It was an open-book take-home exam and was given online. This exam covered the same topic areas as in Section A with the following exceptions: 1) probability, sampling distributions, inference about means, and analysis of variance were also covered; and 2) Chi-square test of association was not covered. Because the two course sections did not use the same exam questions or format, exam scores were standardized within each section by dividing the standardized residual by an estimate of its standard deviation. This yielded a mean of 0 and standard deviation of 1.

Goal Progress (GP)

GS-E was focused on helping students set proximal process goals focused on methods and strategies they were to use to reach two learning objectives for their next statistics exam. Students who received GS-E self-evaluated their goal progress for both of the learning objectives they chose to work on and each of the eight proximal process goals that they set to help them reach these learning objectives. Students were given a copy of their learning objectives and proximal process goals and given the following item: "Use the scale below to rate the amount of progress that you have already made towards each of the following learning objectives and process goals." They rated each learning objective and proximal process goal using the following scale: 1 "No progress," 2 "A little progress," 3 "Some progress," 4 "A fair amount of progress," 5 "Very much

progress." Students' final self-evaluations of the progress they made towards their learning objectives and goals (which was completed at the 2-week delayed post-test) were averaged together to measure students' goal progress.

Effort

Four self-report measures of students' effort over the past 2 weeks were included for exploratory purposes. It was uncertain how the interventions would impact students' effort and no specific hypotheses were made regarding effort.

Course Effort (CE). Student effort towards EDP371 over the past 2 weeks was measured using Ryan's (1982) Effort Subscale (ES) of the Intrinsic Motivation Inventory (IMI). The ES is comprised of four items. McAuley, Duncan, and Tammen (1989) found strong reliability evidence in a study focused on students perceptions of playing a basketball game ($\alpha = .84$). "Over the past 2 weeks" will be added to each item. Items will also be modified to refer to students' EDP371 statistics course (example item: "Over the past 2 weeks, I put a lot of effort into my EDP371 course").

Study Hours (SH). The number of hours students studied for EDP371 over the past 2 weeks was measured with a single item: "Over the past 2 weeks, how many hours did you spend studying or doing work for EDP371?" Students were prompted to type their response into a number box.

Office Hour Visits (OHV). The number of times a student visited their statistics professor over the past 2 weeks was measured with a single item: "Over the past 2 weeks, how many times did you visit your EDP371 professor or teaching assistant during office

hours or by appointment?" Students were prompted to type their response into a number box.

Class Absences (CA). The number of times a students missed class over the past 2 weeks was measured with a single item: "Over the past 2 weeks, how many classes did you miss in your EDP371 course?" Students were prompted to type their response into a number box.

Demographic and Student Experiences Survey

A survey was given to students in order to examine collect demographic information on students as well as their experiences with the interventions and control condition. See Appendix B for the items that were included on this survey.

Description of Intervention and Control Conditions

The experimental conditions were administered using computers in a campus computer lab. The materials were in the form of Microsoft Word 2003 (Microsoft Corporation, 2003) files downloaded from a designated website. For each condition, students read a series of reading passages and complete activities. Students typed their responses to the activities directly into the file. The number of passages, activities and approximate time it took to complete each condition were as follows: GS-E (5 passages, 5 activities, 80 min.), VR-E (7 passages, 7 activities, 80 min.), and, C (3 modules, 3 activities, 80 min.).

Enhanced Goal Setting Intervention (GS-E).

To view GS-E, see Appendix C and D. Appendix C contains the goal setting component of the intervention, and Appendix E contains the self-evaluation component

of the intervention. The Goal Setting Intervention (GS) tested in my master's research (Acee, 2007) was not found to impact students' self-efficacy or exam performance. The goal setting intervention that was tested in this dissertation (GS-E) was an enhanced version of GS. GS-E was different from GS in five important ways. First, GS did not include a section to help students create awareness of their goal setting behaviors in their statistics course. GS-E opened with a section designed to guide students in describing effective and ineffective goal setting for their statistics course, their own goal setting behaviors in the course and how those behaviors affect their motivation and performance in the course.

Second, the focus of GS was on helping students set course goals in general and GS-E was made to be more specific and focus students on setting goals focused on methods and strategies they would use to help them reach learning objectives for their next statistics course exam. GS had students set two long-term goals (which could be focused on anything related to their statistics course) and four proximal sub-goals that could help them reach those long-term goals (but could be either process or product goals). GS-E had students choose two learning objectives for the next exam in their statistics course. For each learning objective, students set four proximal process goals focused on the methods and strategies that they would later use to reach these learning objectives. Two of those goals were to be focused on what to study, that is, students were to set goals focused on the information sources (e.g., course textbook, handouts, practice problems, teaching assistant, and internet resources) that they would study or seek help from in order to reach their learning objective. The other two proximal process goals

were to be focused on how to study, that is, students were to set goals focused on the learning strategies (e.g., summarizing, creating graphic organizers, teaching the material to someone else, and making a list of questions about the material) they would use to learn and retain the information they decided to study. Therefore, students were to set a total of 8 proximal process goals.

Third, GS asked students to specify a start- and end-date for each of their goals but did not require students to specify the time of day they would start working on their goal or guide them in thinking about possible times when they would work on their goal. GS-E asked students to write all of the available times they had to work on their goals over the next 2 weeks. Then students were asked to specify the day, date, and time of day when they would work on their goals using the following statement: "On (specify the day, date, and time to work on the goal), I will (specify goal). GS-E did not ask students to specify an end-date. Research on implementation intentions has suggested that having students phrase their goals using this type of statement (day, date and time) can help students initiate action towards their goals (Gollwitzer, 1999).

Fourth, GS only required a single self-evaluation approximately 14 days after the intervention. GS-E asked students to make 4 self-evaluations of goal progress over the course of 2 weeks (3, 7, 10, and 14 days after the intervention). Furthermore, students were asked to list three ways that they could improve their approaches to reaching each learning objective. More frequent self-evaluation has been suggested to be more effective than only one self-evaluation and having students reflect about what they can do to

improve their approaches has been suggested to be an important aspect of the cyclical nature of self-regulation (Schunk & Ertmer, 1999).

Fifth, GS required students to self-evaluate their goals using goal attainment scales (i.e., a student-created, five-point rating scale that indicates what it means to: fall short of the goal by a lot, fall short of the goal by a little, meet the goal, exceed the goal by a little, and exceed the goal by a lot) (Kiresuk, Smith, & Cardillo, 1994) and by self-reported goal progress using a standard Likert-type response scale that is not student-created ("No progress, A little progress, Some progress, A fair amount of progress, Very much progress"). My master's research showed that students' ratings of goal attainment and goal progress were highly correlated. However, the goal progress measure was more normally distributed than the goal attainment measure. Because goal attainment methods substantially lengthen the time it takes students to complete the intervention, and because the goal progress measure seemed to work just as well if not better than the goal attainment measure, GS-E did not require students to create goal attainment scales for each goal and students rated their goal progress using a standard Liker-type response scale that was not student-created.

The purpose of GS-E was to positively impact students' self-efficacy and exam performance in their EDP371 statistics course by helping students set goals and self-evaluate their goal progress. Students who participated in GS-E read short passages related to goal setting and complete activities designed to help them set more useful goals for EDP371.

Passage 1 (639 words) briefly discussed goal setting and why it is important to set useful goals. Activity 1 asked students to describe the study habits of students who use good and poor goal-setting strategies in their statistics course as well as how their own goal setting affects their motivation and performance in their statistics course.

Passage 2 (1,101 words) discussed and gave examples of process goals (goals focused on the methods and strategies that will be used to reach a learning objective such as learning a concept or mastering a skill). Students were told that process goals can be focused on what to study (i.e., the course material or information sources that need to be access in order to begin learning more about a concept or skill; for example, reading a chapter in a textbook or using the instructor as an information source) and how to study (i.e., the learning strategies and study skills that will be used to learn and retain course material; for example, summarizing course material or writing out a procedure from memory). Activity 2 asked students to choose 2 learning objectives for their upcoming EDP371 exam that they have not yet reached. See Appendix E for a list of learning objectives that were provided to students for each course section. Then, they were guided in setting four process goals for reaching each of those learning objectives (a total of eight process goals). For each learning objective they were instructed to set two process goals focused on what to study and two process goals focused on how to study (a total of eight goals). They were also told to set process goals that could be worked on and achieved within the next 2 weeks. The short-term nature of these goals made them proximal goals and their focus on methods and strategies to reach a learning objective made them process goals.

Passage 3 discussed the benefits of revising process goals so that they were: 1) specific and measurable; and 2) challenging yet realistic. Examples of goal revisions in the area of introductory statistics were provided (e.g., "Instead of saying, 'I will work through some of the practice problems related to calculating z-scores,' you could [make your goal more specific and measurable by saying] "I will complete all 7 of the homework problems that the professor handed out on calculating z-scores"). Activity 3 guided students in revising their eight process goals so that they are specific and measurable and challenging yet realistic.

Passage 4 discussed the importance of stating when action will be initiated towards reaching a process goal. Students were instructed about how to phrase their goals using the following statement: "On (specify day, date, and time), I will (specify goal)." Examples of goal revisions were provided in the area of introductory statistics (e.g., "Instead of saying, 'Without referring back to the book, I will answer 3 sample problems on measures of central tendency from Chapter 3' you could say, 'On Tuesday, January 23rd at 2:30PM, without referring back to the book I will answer 3 sample problems on measures of central tendency from Chapter 3'"). Activity 4 first asked students to list all available times that they had over the next 2 weeks to work on their goals. Then for each of their eight goals, they were asked to specify the day, date, and time of day they intended to work on these goals using the following statement: "On (specify day, date, and time), I will (specify goal)."

Passage 5 instructed students about implementing and evaluating their learning objectives and process goals over the next 2 weeks. The self-evaluative component of

GS-E (see Appendix C) asked students to make four self-evaluations 3, 7, 10, and 14 days after receiving GS-E. Students were sent an e-mail directing them to a website where they were prompted to self-evaluate their progress towards reaching each learning objective and process goal (see "goal progress" under the dependent measures section of Chapter 3 for the exact item and response scale students will use to self-evaluate goal progress). Furthermore, students were asked to describe what they did to reach each learning objective and what they could do to improve their approaches at reaching each learning objective.

As discussed in the procedures section below, students' activities were checked for completeness. Students were asked to go back and complete any activity that was incomplete.

Enhanced Value Reappraisal Intervention (VR-E).

To view VR-E, see Appendix F. The value reappraisal intervention tested in this dissertation study had the same focus, components and flow as the one tested in my master's research. However, several revisions were made. First, minor revisions were made to the wording of the intervention so that it was more clear and comprehensible to the average college student. Second, in my master's research the opening section of the intervention was on the importance of developing a positive attitude for college courses in general. In my dissertation study, this section was revised to focus on students' introductory statistics course, not college courses in general. Third, in the section on intrinsic value, three additional examples were provided and an additional step to an activity was included in order to strengthen that section. Three examples of ways students

can increase their intrinsic value for a task was added: making studying into a game, applying statistics to everyday life, and applying statistics to personal questions about society and the world. In addition one activity was added that had students choose two strategies they will use to increase their intrinsic value for statistics.

The purpose of using VR-E was to help students positively reappraise their value perceptions of their EDP371 introductory statistics course and to develop a continued interest in statistics. Students were presented with messages about the importance of becoming an intelligent consumer of statistics in everyday life (attainment value), academic and professional uses of statistics (utility value), and the intrinsic enjoyment of learning statistics (intrinsic value). Students were also guided in using value reappraisal strategies that asked them to brainstorm, generate rationales, generate mental simulations, and contrast pros and cons related to the importance of learning statistics. Particular emphasis was given to helping students consider the importance of developing statistical knowledge and skills.

Passage 1 (639 words) explained to students what attitudes are and why it is important to construct a positive attitude towards their statistics course. Activity 1 asked students to give examples of students with positive and negative attitudes towards their statistics course. They were also asked to describe their attitude towards their statistics course and how it has affected their motivation and performance in the course. Passage 2 (453 words) explained that one possible route to developing a more positive attitude towards their statistics course was to understand why learning the content and mastering the skills related to that course may be personally important. Activity 2 asked students to

create a list of knowledge and skills that could be developed from learning the content presented in their EDP371 statistics course. In addition, students were asked to: first, create a list of incentives for developing that knowledge and skill; and second, generate mental simulations of them realizing these incentives in the future. Oettingen, Pak & Schnetter's (2001, pp. 740) instructions for generating mental simulations were used.

Passage 3 (482 words) discussed how developing statistical knowledge and skill could help students become more intelligent consumers of statistical information. It pointed to the wide use of statistics in everyday life and discussed misconceptions that can result from being a poor consumer of statistical information. Activity 3 asked students to brainstorm and describe past and future situations where they used or would use statistically based information. They were also asked to generate a rationale for why learning the material in their EDP371 statistics course could help them become more intelligent consumers of statistical information. Passage 4 (70 words) briefly discussed how developing statistical knowledge and skills could help students to become better prepared for future courses. Activity 4 asked students to brainstorm a list of upcoming courses in which having statistical knowledge and skills might be useful and to generate a rational for why learning the material in their EDP371 statistics course could help them in a future course.

Passage 5 (136 words) briefly discussed how developing statistical knowledge and skills could be instrumental in becoming better prepared in a future career and provided examples of how statistics have been used in various careers. In Activity 5 students were asked to create a list of potential careers for them and then to chose one

and describe the ways in which they saw statistical knowledge and skills being used in that career. They were also asked to generate a rationale for why learning statistics could help prepare them for that career. Passage 6 (244 words) briefly discussed how statistics could be challenging, interesting, and enjoyable and gave examples of strategies students could use to make statistics more intrinsically valuable. It was also discussed how negative thoughts related to learning statistics can make it less enjoyable. Activity 6 had students describe three strategies that they could use to increase their interest and enjoyment of statistics. Students were also asked to identify two negative thoughts that they had related to their introductory statistics course and replace each thought with a positive thought. The negative to positive thought replacement aspect of this particular activity was adapted from Weinstein, Woodruff, and Awalt's (2002) Attitude Module.

Passage 7 briefly discussed the importance of summarizing and integrating what they just learned. Activity 7 helped students examine the costs and benefits related to learning statistics. The first part of Activity 7 asked students to generate an argument for and against the importance of statistics and choose which one was truer for them. The second part of Activity 7 asked students to contrast positive incentives for learning statistics with obstacles standing in their way. This activity was adapted from Oettingen, Pak, and Schnetter (2001).

As discussed in the procedures section below, students' activities were checked for completeness. Students were asked to go back and complete any activity that was incomplete.

Control Condition (C).

To view C, see Appendix G. Students who received C completed three of the Texas Information Literacy Tutorial (TILT) modules, earned a 100% on the end-of-module quiz, and answered three reflective questions about each module. The TILT modules were used for C because completing them was not expected to impact the variables of interest but could potentially help students with their library and internet research in other courses and areas of their life. First, students downloaded a document from a designated website that contained instructions for accessing the three TILT modules online. The document also contained three questions that they need to answer after completing each module: 1) summarize, in your own words, the purpose of this module, 2) describe at least three things that you learned from completing this module, 3) describe one future situation in which you will use what you learned from this module. The TILT modules were accessed online at: http://tilt.lib.utsystem.edu. Each module took about 30 minutes. At the end of each module was a nine-item quiz. Students were required to score 100% on each quiz and send their scores to me via the e-mail prompt that appeared after completing the quiz. Module 1 (Selecting) was designed to help students learn to select sources appropriate for academic research. Module 2 (Searching) was designed to help students learn to effectively search library databases and the Web. Module Three (Evaluating) was designed to help students learn how to locate and evaluate print and online sources.

As discussed in the procedures section below, students' activities were checked for completeness. Students were asked to go back and complete any activity that was incomplete.

Procedures

See Table 1 for a flow chart of the study procedures. Students were asked to attend two sessions on campus. Session 1 was held in a PC computer lab with a capacity of 20 students. Sessions were held between 5:15-7:45 PM on weekdays for a period of approximately 2 weeks. I administered all study sessions and no other researchers were involved. First, students were seated at one of the computer stations and asked to read and sign the consent form. Then, students were asked to log onto the computers and complete the pre-test measures, a total of 45 items (see Appendix A), online using Survey Monkey (SurveyMonkey.com, 2008). Then, students were instructed as follows:

> In a moment I will direct you in downloading the electronic workbook. In this workbook you will find short reading passages and activities. The reading passages contain information that will be useful to you when constructing your responses to the activities. The activities will ask you to construct responses that require a deep level of reflection on your part. When completing these activities, it is important that you construct a thoughtful and detailed response; however, do not spend too long on any one activity. Remember that this workbook was designed to benefit you. While completing the workbook, I encourage you to try to reap those benefits. The validity of our research depends on your thorough

engagement in the computerized workbook. So, it is crucial that you carefully read every reading passage and that you thoughtfully complete every activity.

Next, students downloaded from a designated website the file containing the intervention or control condition that they were randomly assigned. They opened the file and begin working. I was available to help students with logistical issues. When students finished, they raised their hand and I came over to examine the completeness of their responses to the intervention or control condition. If students' responses to the activities were incomplete, they were asked to revise them, and if necessary, they were given advice on how to revise their responses.

For the Control Group, I checked if students answered each activity within the condition. I also checked if they sent me their quiz scores via e-mail for each of the three module quizzes they were asked to complete.

For the GS-E Group, I checked if students completed each activity within the intervention and also checked the content of the final revisions of their goals for three major criteria: 1) four goals were generated for each learning objective and were relevant to that learning objective; 2) the goals listed were process goals and not outcome goals (i.e., the goals were focused on methods or strategies they could use to help them reach their learning objective and not focused on earning a particular grade on an assignment or in the course); and 3) the goals specified a specific time and day when they would be worked towards.

For the VR-E Group, I checked if each activity was within the intervention was completed. I also checked if their responses to the activities were germane to introductory statistics and what was being asked of them in the activity.

When students were finished completing with the intervention/control condition, I saved their completed intervention/control condition file to my flash drive. Then students were asked to complete the immediate post-test measures, which were identical to the pre-test measures, online using Survey Monkey. Students then signed up for Session 2. Students who received GS-E were also given hard and electronic (sent via e-mail) copies of their learning objectives and process goals.

During the 2-week delay, students who received GS-E were sent an e-mail 3, 7, and 10 days after the intervention. The e-mail contained the electronic copies of their learning objectives and process goals (in case they lost them) and a link to Survey Monkey where they completed their self-evaluations. Students who received VR-E or C were not required to do anything during this 2-week delay.

Session 2 took place approximately 2 weeks after Session 1. These sessions were also held in a classroom with a capacity of 20 students. They were held from 5:15-5:45PM on weekdays and lasted approximately 30 minutes. First, students who received GS-E were asked to make their final self-evaluation about the progress they made towards reaching their learning objectives and goals. Then, all students completed the 2-week delayed post-test measures, which were identical to the pre-test measures. In addition, students completed demographic items and items about their experiences when completing the intervention or control condition (Appendix F). Students completed all

survey items online using Survey Monkey. Finally, students were thanked and debriefed via e-mail (see Appendix G).

Table 1: *Overview of study procedures.*

Stage of Project	**Week of the Semester**	**Activity**
Pre-Intervention Course Exams	Weeks 4 and 7	• Course Section A: exam given on week 4 • Course Section B: exam given on week 7
Session 1	Weeks 8-9	• Students took pre-test measures • Students completed intervention/control condition • Students took immediate post-test measures
2-Week Delay	Weeks 8-11	• GS-E Group completed 1st, 2nd, and 3rd self-evaluation
Session 2	Weeks 10-11	• GS-E Group completed 4th self-evaluation • Students took 2-week delayed post-test measures • Students took demographic survey
Post-Intervention Course Exams	Weeks 13 and 15	• Course Section A: exam given on week 13 • Course Section B: exam given on week 15
Choice-Behavior Measure	Week 15	• Statistics websites were posted for students to access

Statistical Analyses

The data for self-report measures of self-efficacy (i.e., SECT, SEEP, SERLO), value perceptions (i.e., OTV, END-UV, EXO-UV, IV) and continued interest in statistics (i.e., ICLS) were analyzed using a 3 (Group – GS-E, VR-E, C) x 3 (Time - Pre-Test, Immediate Post-Test, 2-Week Delayed Post-Test) repeated measures analysis of variance (repeated measures ANOVA). F tests using the Greenhouse-Geisser (Geisser & Greenhouse, 1958) degrees of freedom adjustment for violations of the sphericity assumption were used to test the significance of main and interaction effects: group, time, group x time. To control for increases in Type I Error due to the number of dependent variables being tested in this analysis (eight) and to keep the overall level of alpha near .05, a more stringent level of alpha (.01) was used for each F test. Bonferroni adjustments (Bonferroni, 1936; Miller, 1981) were used for post-hoc pairwise comparisons to keep alpha at .05 when delineating significant effects.

A brief discussion regarding why I did not use hierarchical linear modeling (HLM) or repeated measures multivariate analysis of variance (repeated measures MANOVA) is in order. HLM was not used because with three time points only a straight line can be estimated and I wanted to examine if the data curves over time (e.g., an increase from pre-test to immediate post-test and a decrease from immediate post-test to 2-week delayed post-test). I did not use repeated measures MANVOA because I wanted to investigate the impact of the intervention on each outcome separately. This is because each construct being measured is conceptually different, and I also wanted to compare data on these specific measures to past results. Furthermore, the increase in Type I error

that results from conducting multiple univariate tests without a multivariate test as a safeguard can be addressed by making alpha more stringent (e.g., .01 instead of .05).

Analysis of Covariance (ANCOVA) was used to analyze the effect of Group (GS-E, VR-E, C), on students' standardized post-intervention exam scores after controlling for standardized pre-intervention exam scores. To control for increases in Type I Error, a Bonferroni adjustment (Bonferroni, 1936; Miller, 1981) was used for post-hoc pairwise comparisons to keep alpha at .05 when delineating significant effects.

Logistic regression was used to investigate intervention effects on the dichotomous choice-behavior measure of continued interest in statistics (i.e., CBLS). Dummy coded variables were created for intervention group (GS-E – received or not received, and VR-E – received or not received) and entered as predictors of CBLS.

Measures of effect size were also computed for each statistical test to gauge the practical significance of the findings. Partial eta squared (η_p^2) statistics were computed for main and interaction effects tested using repeated measures ANOVA and ANCOVA. Partial eta squared indicates the percent of variance explained by the effect. A partial eta squared value of .01 has been suggested to correspond to a small effect size, .06 medium, and .14 large (Stevens, 1999). Cohen's *d* statistics were computed for post-hoc pair-wise means comparison tests. This statistic indicates the magnitude of the effect in terms of standard deviations. Cohen's *d* effect sizes around .2 have been considered small, .5 medium, and .8 large (Stevens, 1999).

Chapter 4

Results

Preliminary Analyses

Preliminary analyses were conducted to investigate if the proposed statistical analyses were appropriate for the variables that were to be examined and also to inform what variables and cases should be included in the primary analyses. More specifically, the preliminary analyses were conducted to investigate the following: 1) the reliability and descriptive statistics of the study measures; 2) possible violations of the assumptions of the primary statistical analyses that were proposed, 3) the effect of including or excluding potential outliers on study findings; and 4) the effect of including or excluding course section on study findings.

Reliability Analyses

Reliability analyses were conducted for each self-report measure. For self-report measures with multiple items, Cronbach's alpha coefficients (α) were computed to measure the internal consistency among the items at pre-test (see Table 2). The internal consistency was sufficient for each measure (α was equal to .72 for exogenous instrumentality and greater than .87 for all other measures). For each single-item self-report measure, a test-retest reliability analysis was conducted by computing Pearson product-moment correlation coefficients between students' pre-test and 2-week delayed post-test scores (r_{13}). Because VR-E and GS-E were expected to impact students' ratings on these single-item measures, it only made sense to compute test-retest reliabilities for students in the Control Group (n=30). The results from these test-retest reliability

analyses (see Table 2) suggested sufficiently high stability in students' responses to each single-item measure over the 2-week period for students in the Control Group ($r_{13} > .80$ for each single-item measure).

Descriptive Statistics

Means and standard deviations for each pre-test self-report measure are also presented in Table 2. Notice that for the three self-efficacy measures students' mean scores were above the mid-point of the scale. Self-efficacy for Course Tasks (SECT) ($M = 5.64$, $SD = 1.03$) was 1.64 points above the mid-point of the seven-point scale that was used. The means for Self-efficacy for Exam Performance (SEEP) ($M = 90.70$, $SD = 7.05$) and Self-efficacy for Reaching Learning Objectives (SERLO) ($M = 89.02$, $SD = 13.31$) suggested that, on average, students expected to earn an "A" (a score at or above 90%) on their upcoming exam and also expected to reach approximately 89% of the learning objectives for their upcoming exam. On the other hand, students' mean scores for measures of value perceptions were relatively closer to the mid-point of the seven-point scale and in one case lower than the mid-point: Overall Task Value (OTV) ($M = 4.10$, $SD = 1.37$); Endogenous Utility Value (ENDUV) ($M = 4.23$, $SD = 1.33$); Exogenous Utility Value (EXUV) ($M = 4.94$, 1.27); Intrinsic Value (IV) ($M = 3.03$, $SD = 1.33$). Students' lowest mean score was for Intentions to Continue Learning Statistics (ICLS) ($M = 2.57$, $SD = 1.13$).

Table 2: *Reliability and descriptive statistics for self-report measures at pre-test.*

	# of items	*Possible Range*	*M*	*SD*	α	r_{13}
Self-Efficacy for Course Tasks	8	1-7	5.64	1.03	.91	-
Self-Efficacy for Exam Performance	1	0-100	90.70	7.05	-	.81
Self-Efficacy for Reaching Learning Objectives	1	0-100	89.02	13.31	-	.84
Overall Task Value	6	1-7	4.10	1.37	.92	-
Endogenous Utility Value	4	1-7	4.23	1.33	.91	-
Exogenous Utility Value	4	1-7	4.94	1.27	.72	-
Intrinsic Value	7	1-7	3.03	1.33	.95	-
Intentions to Continue Learning Statistics	6	1-7	2.57	1.13	.88	-

Note. N=88. Cronbach's alpha coefficient (α) is a measure of internal consistency reliability. Test-rest reliability (r_{13}) was only calculated for those in the Control Group (n=30).

In addition, the descriptive statistics for exam performance (EP), choice-behaviors for learning statistics (CBLS), and goal progress (GP) were examined. Before standardizing students' post-intervention exam scores their average scores were examined for each course section separately: Course Section A (M = 82.05, SD = 15.15); and Course Section B (M = 88.21; SD = 9.30). These scores were then standardized within each course section by dividing the standardized residual by an estimate of its standard deviation: Standardized post-intervention exam score (M = .00, SD = .99).

CBLS data showed that of the 88 students, 10 students (i.e., 11%) accessed Website A (which was on statistical concepts and skills) and 9 students (i.e., 10%) accessed Website B (which was on how statistics are used in various careers). All students who accessed Website B also accessed Website A.

Goal progress (GP) data was limited to students in the GS-E Group because these data were collected as part of students' self-evaluations. Students in the GS-E Group were asked to self-evaluate the progress they made towards reaching the two learning objectives and the eight goals they set to help them reach these learning objectives 4 times over a 2-week period. Only data from the last self-evaluation, which was given during the 2-week delayed post-test, were used because these data most accurately reflected the progress students made at the end of the 2 week delay. Students' goal progress ratings on the two learning objectives and eight goals that they set were averaged together to measure GP (M = 3.50, SD = 1.19). The internal consistency among these 10 ratings was very high (α =.98). GP used a 5-point scale where higher scores indicated greater goal progress. Notice that students' average scores are slightly above the mid-point of the scale.

Intercorrelations

The intercorrelations among self-report measures are presented in Table 3. These results show many positive and significant correlations (out of the 28 correlations that were examined, 17 were significant). All correlations that were significant were significant at the $p < .01$ level. All significant correlations were also positive. It was interesting that exogenous utility value (EXOUV) was the only variable that was not

significantly related to any of the other variables. All three self-efficacy measures (SECT, SEEP, and SERLO) had significant positive correlations among each other that ranged from .56 to .64. Also, with the exception of exogenous utility value, measures of value perceptions (OTV, ENDUV, and IV) were positively correlated with each other and those correlations ranged from .54 to .80. OTV was highly correlated with ENDUV ($r = .78$, $p < .01$) and IV ($r = .80$, $p < .01$), whereas, ENDUV and IV had a medium correlation ($r = .54$, $p < .01$). Self-efficacy measures and value perception measures also had several positive correlations. SECT was positively correlated with each value perception measure except EXOUV and these correlations ranged from .37 to .52. Also, SECT and SERLO were positively correlated with two value perception measures (OTV and INV) and these correlations were small and ranged from .28 to .31. Intentions for Continuing to Learn Statistics (ICLS) was positively correlated with one self-efficacy measure (SECT: $r = .40$, $p < .01$) and three value perceptions measures: OTV ($r = .54$, $p < .01$); ENDUV ($r = 47$, $p < .01$); and IV ($r = .54$, $p < .01$). As was expected, these results showed that many of the self-report study outcomes were intercorrelated. Despite these correlations, each outcome was examined independently in order to compare results from this study with my master's thesis as well as other prior research on these specific measures.

Table 3: *Correlations among self-report measures.*

	1	2	3	4	5	6	7	8
Self-Efficacy for Course Tasks	1							
Self-Efficacy for Exam Performance	.64**	1						
Self-Efficacy for Reaching Learning Objectives	.56**	.61**	1					
Overall Task Value	.49**	.28**	.29**	1				
Endogenous Utility Value	.37**	.10	.05	.78**	1			
Exogenous Utility Value	-.09	.01	-.07	-.20	-.19	1		
Intrinsic Value	.52**	.29**	.31**	.80**	.54**	-.07	1	
Intentions to Continue Learning Statistics	.40**	.16	.19	.54**	.47**	-.15	.54**	1

Note. ** $p < .01$.

Examination of Assumptions

Each statistical analysis procedure that was used in this dissertation study has a set of assumptions about the variables being analyzed and their relationships with one another. Before using a statistical analysis procedure, violations of its assumptions were examined. According to Stevens (2002) assumptions for repeated measures ANOVA with a between subjects variable include: 1) independence of observations; 2) multivariate normality, 3) sphericity; and 4) homogeneity of covariance matrices. The

independence assumption was protected against in the design by randomly assigning participants to groups and having them complete the study independently at individual computer stations. Furthermore, to examine if any differences between experimental groups existed at pre-test, separate ANOVA's were conducted for each self-report measure (i.e., SECT, SEEP, SERLO, OTV, ENDUV, EXOUV, IV, and ICLS) as well as pre-intervention exam performance and students' age. No significant differences were found. This suggested that the intervention and control groups were comparable on these variables at pre-test; thus, allowing for more valid group comparisons over time. Violations of multivariate normality were not a strong concern because repeated measures ANOVA has been found to be robust (with respect to Type I error) to violations of multivariate normality (Stevens, 2002). Nonetheless, the frequency distribution, skewness, and kurtosis of each dependent variable was examined and deemed normal enough to use in analyses. The Greenhouse-Geisser (Geisser & Greenhouse, 1958) procedure was used to correct for violations of the sphericity assumption. The violations of homogeneity of covariance matrices assumption was not a strong concern because repeated measures ANOVA has been found to be robust (with respect to Type I error) to this violation when group sizes are similar (Stevens, 2002). Group sizes were similar in this dissertation study because of random assignment to groups. Nonetheless, Box's Test of Equality of Covariance Matrixes was conducted for each self-report measure. Out of the eight measures tested, one measure, SERLO, was found to have a statistically significant violation.

ANCOVA with one between-subjects factor (group) and one covariate (pre-intervention exam performance) has the following five assumptions: 1) independence of observations; 2) normality; 3) homogeneity of variance; 4) homogeneity of regression slopes; and 5) linearity of regression (Pituch, 2003). The first two assumptions were discussed above in the paragraph on the assumptions of repeated measures ANOVA, but the last four were not. Homogeneity of variance was examined using Levene's Test of Equality of Error Variances (Levene, 1960) and no violation was detected. Homogeneity of regression slopes was examined by testing the significance of the interaction between the between-subjects variable and the covariate (Pituch, 2003). Linear regression was used to test this interaction. Two dummy coded variables were created for group: VR-E - received vs. not received; and GS-E - received vs. not received. Each dummy coded variable was multiplied by students' standardized pre-intervention exam score in order to create both interaction terms (i.e., VR-E*standardized pre-intervention exam score and GS-E*standardized post-intervention exam score). Then, standardized pre-intervention exam score, both dummy coded group variables, and both interaction terms were regressed incrementally on standardized post-intervention exam score. Adding both interaction terms to the model of main effects did not result in a significant R-Square change. Also, neither interaction term was found to be statistically significant. Therefore, the interaction between intervention group and pre-intervention exam score was not included in the primary analyses, and traditional ANCOVA procedures were used. The linearity of regression assumption was assessed by inspecting the scatter plot between the covariate (pre-intervention exam performance) and outcome (post-intervention exam

performance) with each group (GS-E, VR-E, and Control) to determine if the relationship was reasonably linear. The scatter plots for each group appeared to be linear.

Logistic regression does not assume normality or homogeneity of variances, but, it does assume: 1) independence of observations; 2) linearity between the independent variables and the log odds of the dependent variable; and 3) the absence of perfect multicollinearity (Orme & Combs-Orme, 2009). The independence of observations assumption was discussed above in the paragraph on the assumptions of repeated measures ANOVA. The relationships between the independent variables and the log odds of the dependent variable were linear because both of the independent variables were dichotomous (GR-E – received vs. not received; and VR-E – received vs. not received) and thus could not have a curvilinear relationship with the dependent variable. Also, because the independent variables were orthogonal, there was no multicollinearity between them.

Preliminary Exploratory Analyses

The major focus of the primary analyses was on the effect of the variable Group (Control, GS-E, VR-E) on the dependent variables. However, before conducting the primary analyses, it was important to explore the interaction between Group and Course Section (A, B). It was possible that the intervention could have differentially affected students in Course Section A compared to Course Section B. Therefore for each of the statistical analyses presented in the Primary Analyses section below, a preliminary exploratory analysis was conducted first to examine the main and interactive effects of Group and Course Section. For each dependent variable, there was not a statistically

significant effect of Course Section and there was not a statistically significant interaction between Group and Course Section. Therefore, the variable Course Section was not included in the primary analyses.

Another area of preliminary exploration was to examine the effect of including or excluding outliers on the study findings. The standardized residuals for each dependent variable were analyzed and two variables were identified as having potential outliers: self-efficacy for reaching learning objectives (SERLO), and post-intervention exam performance (EP). For both of these dependent variables, separate analyses were run that excluded outliers and included outliers. The findings were not different whether the outliers were included or excluded. Hence, it was decided to include all 88 cases in the primary analyses for both SERLO and EP.

Primary Analyses

The data for self-report measures of self-efficacy (i.e., SECT, SEEP, SERLO), value perceptions (i.e., OTV, END-UV, EXO-UV, and IV) and continued interest in statistics (i.e., ICLS) were analyzed using a 3 (Group – GS-E, VR-E, and C) x 3 (Time - Pre-Test, Immediate Post-Test, and 2-Week Delayed Post-Test) repeated measures analysis of variance (repeated measures ANOVA). As discussed in the Preliminary Analysis section above, these data did not violate the assumptions of repeated measures ANOVA in any way that was of concern. Also, there were no interactions between Group and Course Section so Course Section was not included in the analyses presented below. Finally, removing outliers did not change the study findings so all 88 cases were retained in the analyses presented below.

Self-efficacy beliefs

Group means and standard deviations for each self-efficacy measure at each time point are presented in Table 4 at the end of this section.

Self-efficacy for Course Tasks (SECT)

Repeated measures ANOVA results revealed no statistically significant intervention effects on SECT.

Self-efficacy for Exam Performance (SEEP)

Repeated measures ANOVA results revealed no statistically significant intervention effects on SEEP.

Self-efficacy for Reaching Learning Objectives (SERLO

Repeated measures ANOVA results revealed no statistically significant intervention effects on SERLO.

Table 4: *Descriptive statistics for self-efficacy beliefs over time by group.*

	Pre-test		Immediate Post-test		2-Week Post-Test	
	M	*SD*	*M*	*SD*	*M*	*SD*
Self-Efficacy for Course Tasks						
Control	5.48	1.11	5.51	.89	5.39	.90
GS-E	5.72	1.01	5.83	.90	5.80	.94
VR-E	5.73	.97	5.92	.79	5.69	.92
Self-Efficacy for Exam Performance						
Control	89.23	7.28	89.20	6.83	88.23	8.61
GS-E	91.41	6.50	91.59	6.48	91.04	7.10
VR-E	91.52	7.27	92.19	6.42	91.06	6.57
Self-Efficacy for Reaching Learning Objectives						
Control	88.07	13.02	87.80	12.49	88.50	11.70
GS-E	91.26	8.47	91.67	8.36	90.89	8.25
VR-E	88.00	16.77	92.10	7.76	89.48	8.86

Note. No means within the same row are significantly different at $p < .01$. Control (n=30), GS-E (n=27), and VR-E (n=31).

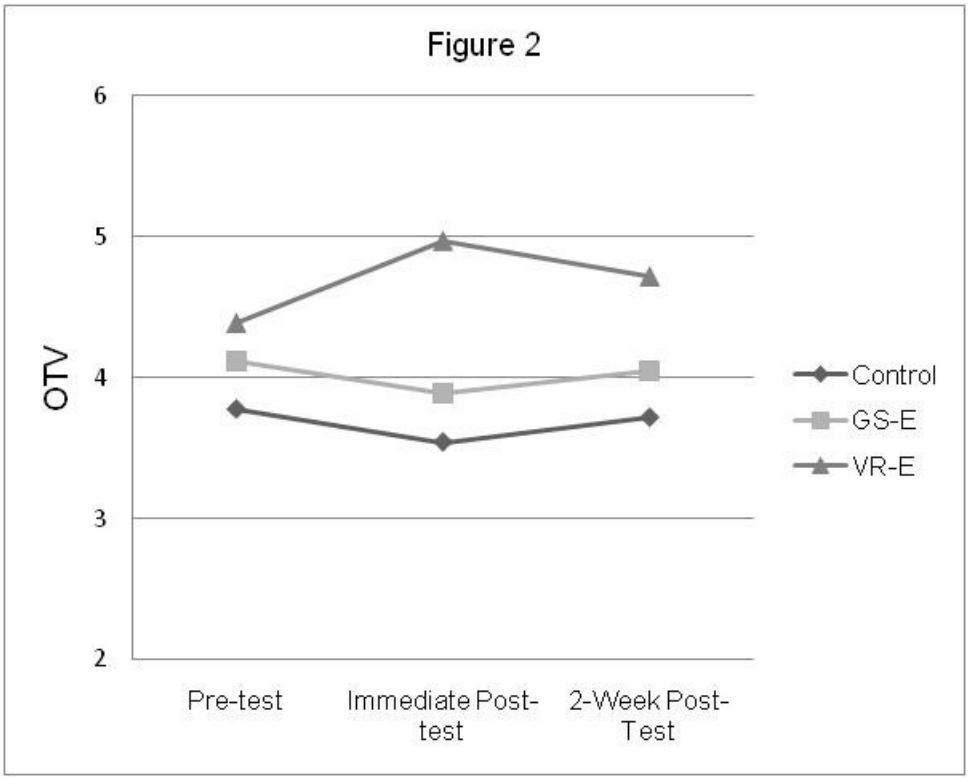
Value Perceptions

Group means and standard deviations for each value perception measure at each time point are presented in Table 5 at the end of this section.

Overall Task Value (OTV)

Repeated measures ANOVA results for OTV showed a strong Group x Time interaction ($F = 5.22$, $p < .01$, $\eta_p^2 = .11$) (see Figure 2). Post hoc tests using Bonferroni adjustments suggested that neither the Control Group nor the GS-E Group made statistically significant gains or losses on OTV over time. Conversely, the VR Group made statistically significant gains on OTV from pre-test to immediate post-test (*M*-difference = .59, *SE* = .13, *CI* = .44 to .91, $p < .01$, $d = .46$). These intervention effects were not found to attenuate significantly from immediate post-test to two-week delayed post-test. In addition, the VR Group did not evidence statistically significant gains on OTV from pre-test to 2-week delayed post-test.

Figure 2. Group by time interaction on Overall Task Value (OTV).

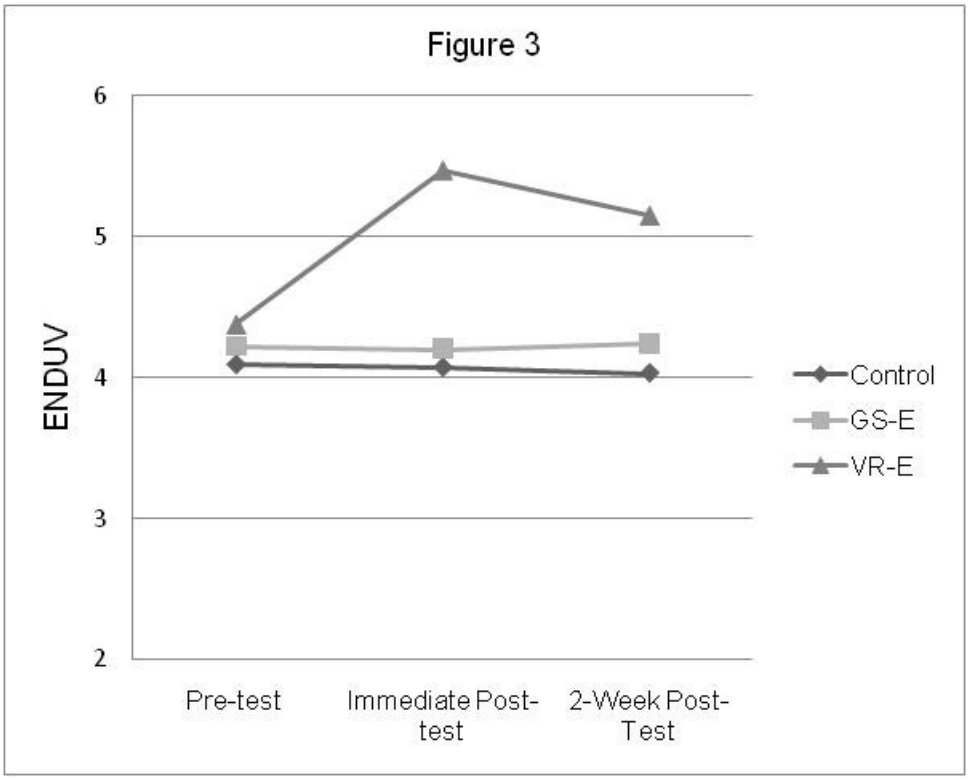


Endogenous Utility Value (ENDUV)

A strong Group x Time interaction ($F = 7.54$, $p < .01$, $\eta_p^2 = .15$) was detected (see Figure 3). Post hoc tests using Bonferroni adjustments suggested that neither the Control Group nor the GS-E Group made statistically significant gains or losses on ENDUV over time. On the other hand, the VR Group made statistically significant gains on ENDUV from pre-test to immediate post-test (*M*-difference = 1.09, *SE* = .16, *CI* = .69 to 1.48, $p < .01$, $d = .82$). These intervention effects were not found to attenuate significantly from immediate post-test to two-week delayed post-test. Furthermore, the VR Group made

statistically significant gains on ENDUV from pre-test to 2-week delayed post-test (*M*-difference = .77, *SE* = .19, *CI* = .32 to 1.23, $p < .01$, $d = .56$).

Figure 3. Group by time interaction on Endogenous Utility Value (ENDUV).



Exogenous Utility Value (EXOUV)

Repeated measures ANOVA results revealed no statistically significant intervention effects on EXOUV.

Intrinsic Value (IV)

A Group x Time interaction ($F = 4.49$, $p < .01$, $\eta_p^2 = .10$) was detected (see Figure 4). Post hoc tests using Bonferroni adjustments suggested that neither the Control Group

nor the GS-E Group made statistically significant gains or losses on IV over time. On the other hand, the VR Group made statistically significant gains on IV from pre-test to immediate post-test (*M*-difference = .52, *SE* = .10, *CI* = .27 to .77, $p < .01$, $d = .39$). These intervention effects were not found to decrease significantly from immediate post-test to two-week delayed post-test. Also, the VR Group did not make statistically significant gains from pre-test to 2-week delayed post-test.

Figure 4. Group by time interaction on Intrinsic Value (IV).

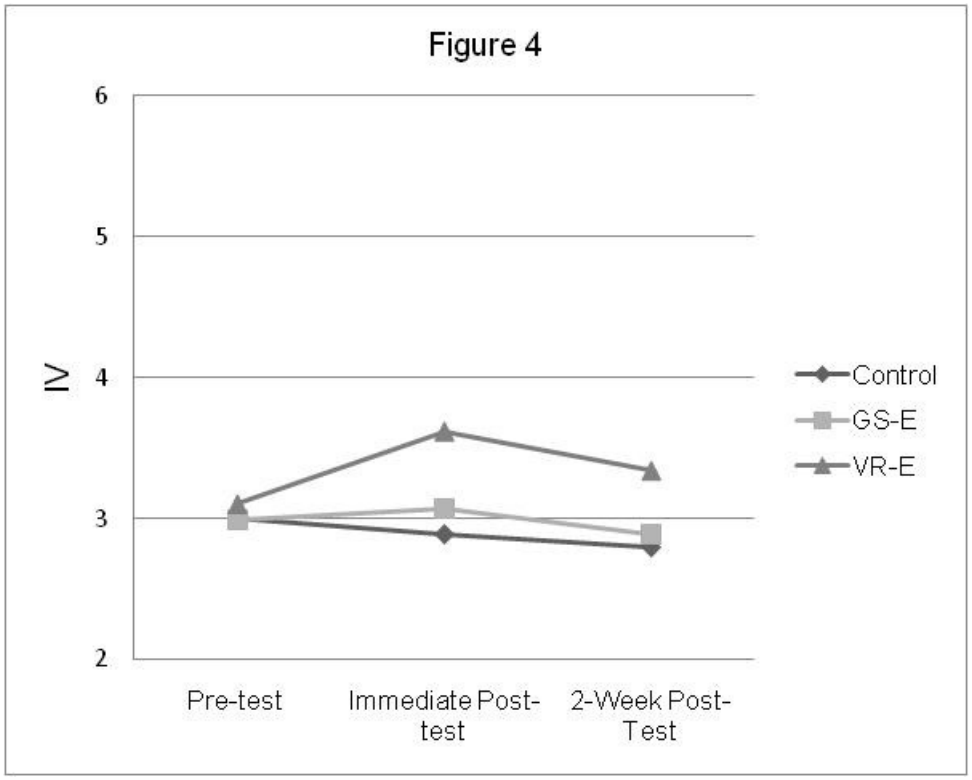


Table 5: *Descriptive statistics for value perceptions over time by group.*

	Pre-test		Immediate Post-test		2-Week Post-Test	
	M	*SD*	*M*	*SD*	*M*	*SD*
Overall Task Value						
Control	3.78	1.39	3.54	1.23	3.72	1.33
GS-E	4.12	1.31	3.89	1.33	4.05	1.52
VR-E	4.39_{a}	1.37	4.97_{a}	1.17	4.72	1.19
Endogenous Utility Value						
Control	4.09	1.30	4.07	1.27	4.03	1.41
GS-E	4.22	1.15	4.20	1.22	4.24	1.45
VR-E	4.38_{ab}	1.52	5.47_{a}	1.15	5.15_{b}	1.23
Exogenous Utility Value						
Control	5.23	1.22	5.17	1.22	5.26	1.22
GS-E	4.80	1.25	4.83	1.15	4.75	1.22
VR-E	4.79	1.31	5.03	1.24	5.22	1.38
Intrinsic Value						
Control	3.00	1.25	2.89	1.13	2.80	1.20
GS-E	2.99	1.49	3.07	1.52	2.89	1.61
VR-E	3.10_{a}	1.31	3.62_{a}	1.36	3.34	1.38

Note. Means in the same row sharing the same subscript are significantly different at $p < .01$. Control (n=30), GS-E (n=27), and VR-E (n=31).

Continued Interest

Intentions to Continue Learning Statistics (ICLS)

Group means and standard deviations on ICLS at each time point are presented in Table 6. A similar pattern of results emerged for ICLS as it did for ENDUV. A strong VR x time interaction ($F = 6.89$, $p < .01$, $\eta_p^2 = .14$) was detected (see Figure 5). Post hoc tests using Bonferroni adjustments suggested that neither the Control Group nor the GS-E Group made gains or losses on ICLS over time. However, the VR Group made statistically significant gains on ICLS from pre-test to immediate post-test (*M*-difference = .81, *SE* = .13, *CI* = .49 to 1.13, $p < .01$, $d = .70$). These intervention effects were not found to attenuate significantly from immediate post-test to two-week delayed post-test. Furthermore, the VR Group made statistically significant gains on ICLS from pre-test to 2-week delayed post-test (*M*-difference = .79, *SE* = .14, *CI* = .45 to 1.13, $p < .01$, $d = .69$).

Figure 5. Group by time interaction on Intentions to Continue Learning Statistics (ICLS).

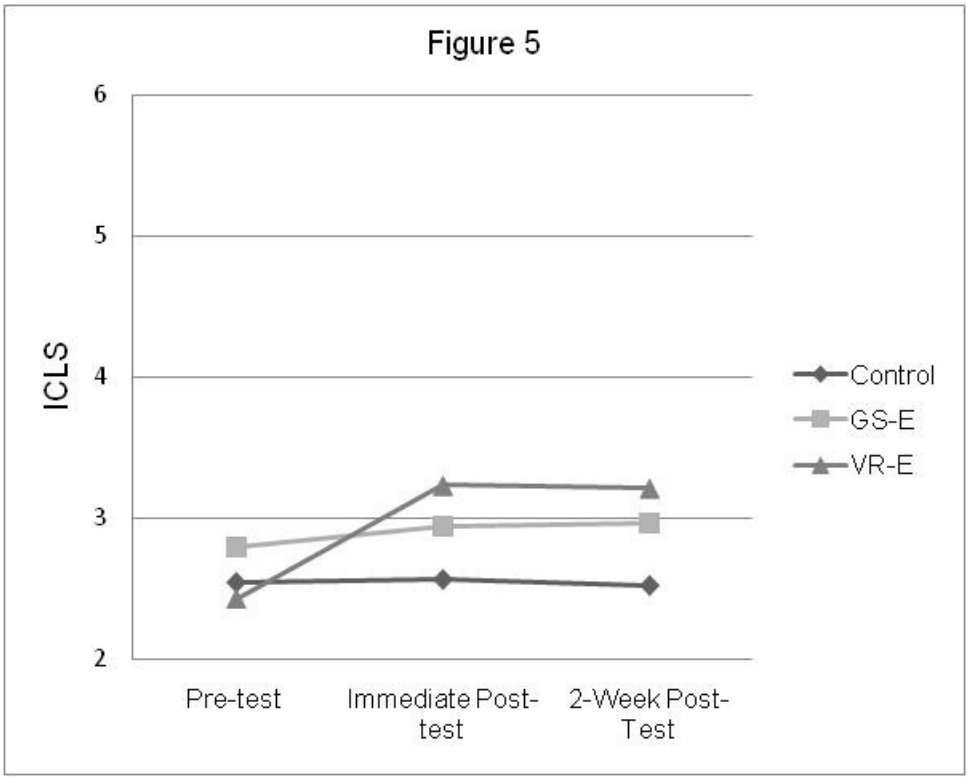


Table 6: *Descriptive statistics for Intentions to Continue Learning Statistics over time by group.*

	Pre-test		Immediate Post-test		2-Week Post-Test	
	M	*SD*	*M*	*SD*	*M*	*SD*
Intentions to Continue Learning Statistics						
Control	2.54	1.09	2.56	1.00	2.52	1.13
GS-E	2.79	1.24	2.94	1.25	2.96	1.36
VR-E	2.42_{ab}	1.07	3.23_{a}	1.26	3.21_{b}	1.23

Note. Means in the same row sharing the same subscript are significantly different at $p < .01$. Control (n=30), GS-E (n=27), and VR-E (n=31)

Choice-Behaviors to Learn Statistics (CBLS)

Whether or not students accessed two statistics websites that were posted on their course section's website was tracked and used to measure CBLS. One website, Website A, had information on statistical terminology and procedures. The other website, Website B, had information on how statistics are used in a variety of professions. Once students accessed a website, they could then save the website link to their computer and access it again later without being tracked. Therefore, the frequency of times students accessed a website was not of interest. Instead, a dichotomous variable indicating whether or not students accessed a website was of interest: Website A (1 = accessed, 0 = not accessed) and Website B (1 = accessed, 0 = not accessed. Of the 88 students, 10 accessed Website A: Control Group (n=2), GS-E Group (n=6), VR-E Group (n=2). Nine accessed Website

B: Control Group (n=2), GS-E Group (n=5), VR-E Group (n=2) (see Table 7). All students who accessed Website B also accessed Website A. However, one student accessed Website A but did not access Website B.

Logistic regression analysis was used to investigate the statistical significance of intervention effects on both CBLS measures (i.e., Website A and Website B). However in order to conduct these analyses, the variable Group, which had three levels (Control, GS-E, and VR-E), needed to be dummy coded. This was done by creating two variables GS-E (1 = present, 0 = absent) and VR-E (1 = present, 0 = absent). Logistic regression analyses were conducted separately for Website A and Website B. GS-E and VR-E were entered into a model predicting Website A. The model was not statistically significant and only explained 5% of the variation in students' choice-behaviors. The model for Website B was also not statistically significant and explained only 3% of the variation in students' choice-behaviors.

Table 7: *Descriptive statistics for Choice-Behaviors to Learn Statistics by group.*

	Accessed Website A		*Accessed Website B*	
	Frequency	*% with Group*	*Frequency*	*% with Group*
Choice-Behaviors to Learn Statistics				
Control	2	6.7	2	6.7
GS-E	6	22.2	5	18.5
VR-E	2	6.5	2	6.5

Note. Control (*n*=30), GS-E (*n*=27), and VR-E (*n*=31). There were no statistically significant group differences.

Exam Performance (EP)

Group means and standard deviations on ICLS at each time point are presented in Table 8. The data on students' standardized post-intervention exam scores were analyzed using analysis of covariance (ANCOVA). Students' pre-intervention exam scores were entered as a covariate and the main effect of Group (GS-E, VR-E, and C) was examined. As discussed in the data analysis section above, these data did not violate the assumptions of analysis of covariance in any way that was of concern. However, there was one case that could potentially be considered an outlier (this student had a post-intervention standardized exam score of -3.71). Removing this case did not change the findings for exam performance so it was included in the analysis.

ANCOVA results for post-intervention exam scores showed a statistically significant main effect of Group ($F=5.16$, $p<.01$, $\eta_p^2=.11$) (see Figure 6). Also the

covariate in the model, pre-intervention exam scores, was also found to be a statistically significant positive predictor of post-intervention exam scores (F=32.66, p<.01, η_p^2=.28). The Group means of students' adjusted post-intervention exam scores (they were adjusted for pre-intervention exam scores) showed that the GS-E Group had the lowest mean score, the VR-E Group had the highest mean score, and the Control Group's mean score was in the middle. Post-hoc analyses using Bonferroni adjustments suggested that the only statistically significant difference between groups was between the GS-E Group and the VR-E Group (*M*-difference = .70, *SE* = .22, *CI* = .17 to 1.24, $p < .01$).

Figure 6. Group effect on post-intervention exam performance.

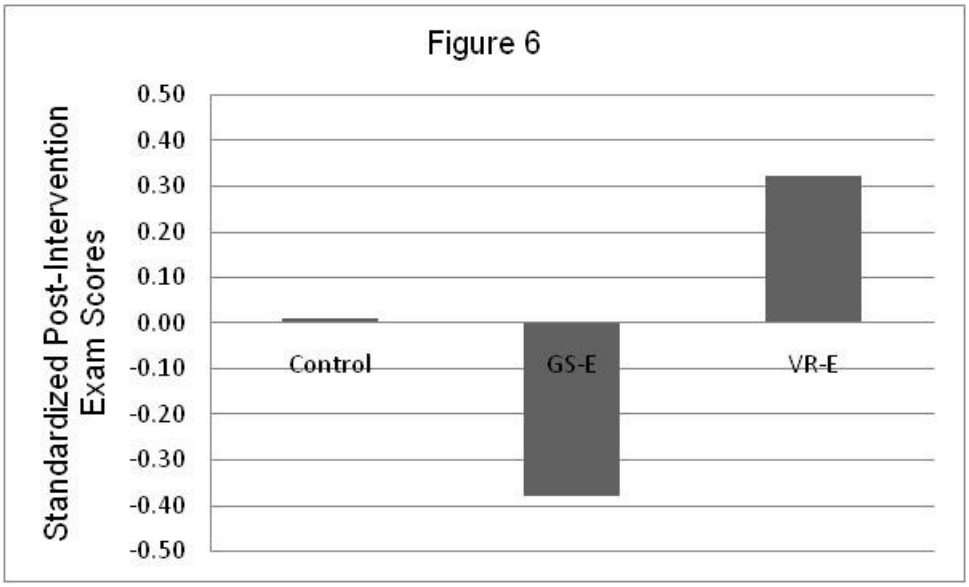


Table 8: *Group effect on post-intervention exam performance.*

	*M**	*SE*
Standardized Post-Intervention Exam Scores		
Control	.01	.15
GS-E	$-.38_a$	.16
VR-E	$.32_a$	.15

Note. *Means were adjusted for standardized pre-intervention exam scores. Means sharing the same subscript are significantly different at $p < .01$. Control (n=30), GS-E (n=27), and VR-E (n=31).

Post-hoc Exploratory Analyses

The GS-E Intervention did not impact any of the study outcomes. One possible explanation of for these null findings was that the GS-E Intervention only benefited students who made progress towards reaching their goals. If this was the case, it is possible that students who did not make progress towards their goals could have masked the effects of the GS-E Intervention on the study outcomes. One way to examine this hypothesis was to focus on students in the GS-E Group and investigate the relationships between goal progress and study outcomes. A repeated measures ANOVA was run for students in the GS-E Group (n=27), and the interaction between goal progress group (Low Group (n=9), Medium Group (n=9), and High Group (n=9)) and Time (Pre-test, 2-week delayed post-test) was examined for each dependent measure. Also, an ANCOVA was run to examine the relationship between goal progress group and post-intervention

exam scores, controlling for pre-intervention exam scores. There was no effect of goal progress detected for any of the study outcomes. (I also conducted analyses using linear regression by entering pre-test and goal progress, which was entered as a continuous variable, as predictors of post-test scores to see if doing so resulted in different findings and it did not).

Chapter 5

Discussion

It was hypothesized that the GS-E Intervention would positively impact students self-efficacy beliefs and exam performance, whereas, the VR-E Intervention would positively impact students' value perceptions and continued interest. Therefore, these interventions were expected to differentially affect the study outcomes. The results partially supported the hypotheses related to the VR-E Intervention, but there was no support for the hypotheses related to the GS-E Intervention.

Enhanced Goal Setting (GS-E) Intervention

It was hypothesized that students in the Enhanced Goal Setting (GS-E) Group would make stronger gains on measures of students' self-efficacy beliefs and exam performance compared to students in the Control Group and VR-E Group. There was no support found for either of these hypotheses. What follows is a discussion of the findings related to self-efficacy and the findings for exam performance. Lastly, I will speculate about why there were null findings for the GS-E Intervention.

Self-efficacy beliefs

Self-efficacy beliefs were hypothesized to increase from pre-test to immediate post-test and from pre-test to 2-week delayed post-test for students in the GS-E Group. Three types of self-efficacy beliefs were measured: self-efficacy for course tasks (SECT), self-efficacy for exam performance (SEEP), and self-efficacy for reaching learning objectives (SERLO). For all three of these self-efficacy measures, there were no statistically significant effects of the GS-E Intervention observed (nor were there effects

of the VR-E Intervention or Control Condition). Therefore, the hypotheses related to the positive impact of GS-E on self-efficacy beliefs were not supported by the data.

Some theory and research on goal setting has suggested that merely setting a goal can lead to immediate increases on students' self-efficacy for reaching that goal (Gollwitzer, 1999; Pintrich & Schunk, 2002). The data from this study did not support this notion. Students were asked to set eight goals focused on methods and strategies they could use to reach two learning objectives for an upcoming exam. The results from this study showed no immediate impacts of GS-E on students' self-efficacy for course tasks, self-efficacy for exam performance, or self-efficacy for reaching learning objectives.

Social-cognitive research on goal setting and self-evaluation has suggested that when students observe themselves making progress towards reaching their goals doing so can lead to increases in self-efficacy. However, when no such progress is observed researchers have suggested that self-efficacy will likely remain unchanged (Kitsantas, Reiser, & Doster, 2004; Schunk, 1996; Schunk and Ertmer, 1999). In this dissertation study, students were asked to self-evaluate the progress they made towards reaching their goals four times over a 2-week period. Data from these self-evaluations suggested that, on average, students reported making moderate progress towards their goals over this 2-week period. However, increases in self-efficacy were not observed. Also, exploratory analyses were conducted to examine the post-hoc hypothesis that students who made more progress towards their goals would report stronger increases on self-efficacy measures compared to students who made less progress on their goals. No support for this hypothesis was found. Therefore, findings from this study are not in line with social-

cognitive theory and research on goal setting and self-evaluation which suggest that goal setting and self-evaluation can lead to increases in students' self-efficacy beliefs (Bandura & Schunk, 1981; Kitsantas, Reiser, & Doster, 2004; Schunk, 1996; Schunk and Ertmer, 1999; Zimmerman, Bandura, & Martinez-Pons, 1992). In the section below entitled "Some Possible Explanations for the Null Findings" possible reasons for why the GS-E Intervention may not have been effective at impacting students' self-efficacy beliefs are discussed.

Exam Performance

There was no support found for the hypothesis that students in the GS-E Group would have higher post-intervention exam scores than students in the Control Group and VR-E Group; in fact, the findings from this study suggested quite the opposite. The results for exam performance were surprising because students in the GS-E Group had the lowest average exam scores compared to the other two groups. The VR-E Group had the highest average exam score and the Control Group's average exam score was in between the average scores of the GS-E Group and VR-E Group. The only statistically significant group difference for exam performance was between students in the GS-E Group and VR-E Group. These results might suggest that the GS-E Intervention may have hindered students' performance on the exam, whereas, the VR-E Intervention may have facilitated students' performance on the exam. However, it was difficult to interpret these findings because neither group was significantly different than the Control Group on exam performance. Therefore, suggestions about how GS-E hindered or VR-E facilitated students' exam performance can only be made in reference to the other

intervention, not in reference to the Control Condition. Research on goal setting has suggested positive effects of proximal goals (e.g., Bandura, & Schunk, 1981), process goals (e.g., Schunk & Ertmer, 1999), moderately difficult and specific goals (e.g., Locke & Latham, 2002), and implementation intentions (e.g., Gollwitzer, 1999) on task performance. Furthermore, research has suggested that self-evaluating one's progress towards reaching goals can help to facilitate goal attainment (e.g., Kitsantas, Reiser, & Doster, 2004; Schunk & Ertmer, 1999). Findings from this study were not in line with this research. GS-E was not found to facilitate students' exam performance and, in fact, there was tentative evidence to suggest that GS-E might actually hinder students' exam performance.

Value Perceptions and Continued Interest

As expected, there were no effects of the GS-E Intervention on students' value perceptions and continued interest. However, the GS-E Intervention was not effective at impacting students' self-efficacy beliefs and exam performance. Therefore, it remains unknown whether or not a goal setting intervention that is effective at improving students' self-efficacy beliefs and exam performance could also lead to increases in students' value perceptions and/or continued interest.

Some Possible Explanations for the Null Findings

GS-E was designed to address some of the flaws that were identified in the Goal Setting (GS) Intervention that was investigated in my master's thesis. GS had students set course goals but students were free to set outcome or process goals focused on different aspects of the course (e.g., goals focused on assignments they wanted to complete, goals

focused on exam scores they wanted to earn). The GS-E Intervention, on the other hand, asked students to set proximal process goals that were focused on methods and strategies they could use to reach learning objectives for their upcoming introductory statistics exam. In addition, students were asked to make more frequent (four compared to one) self-evaluations of their goal progress in the GS-E Intervention. Apparently these "enhancements" did not improve the effectiveness of the intervention enough to produce observable increases in students' self-efficacy beliefs and exam performance. What follows is a discussion of other possible reasons for why the GS-E Intervention was found not to be effective.

GS-E incorporated strategies put forth in theory and research on goal setting and self-evaluation. More specifically, GS-E asked students to set four proximal process goals for reaching two learning objectives, revise their goals so that they were moderately difficult and specific, phrase their goals using implementation intentions, and self-evaluate their progress towards reaching their goals 4 times over 2 weeks. Much of the research conducted on goal setting and self-evaluation strategies has examined these strategies in isolation. This research is different because it incorporated many strategies into one intervention. It is possible that some of these strategies interacted or interfered with each other in a way that lessened the potential impact of using a particular strategy.

In addition, asking students to use multiple goal setting strategies in a relatively short amount of time might have lead to a superficial use of these strategies. It is possible that students needed more time and more practice to effectively use the goal setting and self-evaluation strategies presented to them in the GS-E Intervention. Breaking GS-E into

several parts and having students complete these parts in multiple sessions over a longer period of time might have been more effective.

Also, despite the length and amount of practice involved in the GS-E intervention, it might take longer for the GS-E Intervention to impact study outcomes than what was measured in this study. A major point of self-regulated learning is to help students' self-evaluate the utility of their learning methods and strategies so that they can learn from their mistakes and improve their strategic approaches on subsequent tasks (Zimmerman, 2000). This study may not have measured self-efficacy and exam performance far enough into the future to detect possible improvements students may have made to the methods and strategies they use to study for course exams. This study was focused on the first exam given after the administration of the interventions and control condition (4-7 weeks later). This exam was the major performance outcome used in this study. Also, the GS-E Intervention had students set goals focused on methods and strategies they could use to learn material for this exam. While students were asked to self-evaluate the progress they made towards their goals and were also asked to discuss what they could do to improve their strategic approaches, it is possible that students did not make major adaptations and improvements to their learning methods and strategies until after receiving the results from the exam. For example, it might not be until after receiving an unsatisfactory exam score that students would begin to make major changes in how they study. In order to detect an impact of the GS-E Intervention on self-efficacy beliefs and exam performance, it might be important to give students enough time to learn from and correct their mistakes over a series of tasks (and also scaffold guidance to students in using goal

setting and self-evaluation strategies on these tasks). Accordingly, positive effects of the GS-E Intervention might be stronger for subsequent tasks than tasks that are the initial focus of the intervention. If the GS-E Intervention would have been given earlier in the semester, there may have been enough time to examine the impact of GS-E on multiple exams. However, given the time restraints of the human subjects pool used this was not possible to implement in this study.

Intervention research on goal setting and self-evaluation in educational settings has largely focused on embedding self-regulatory prompts within teacher instructions and academic tasks in order to prompt students to adopt goals and self-evaluate their goal progress. Much of the research conducted on proximal goals, process goals, difficult goals, and specific goals does not actually require students to set goals (Bandura, & Schunk, 1981; Kitsantas, Reiser, & Doster, 2004; Locke & Latham, 2002; Schunk, 1983; Schunk, 1996; Schunk & Ertmer, 1999). GS-E guided students in writing out goals for themselves and revising them so that they were more useful. Also, students' self-evaluations were in reference to the goals they set. Having students generate their own goals could possibly be less effective than prompting them with goals. It would probably be disconcerting to researchers and practitioners if findings from research on goal setting and self-evaluation did not transfer to interventions where students actually set goals. It is important to make clear, however, that the data from this study is insufficient to explain why there were null findings for the impact of the GS-E Intervention.

Enhanced-Value Reappraisal Intervention

It was hypothesized that students in the Enhanced Value Reappraisal (VR-E) Group would make stronger gains on measures of value perceptions and continued interest in learning statistics compared to students in the Control Group and GS-E Group. There was partial support found for these hypotheses.

Value Perceptions

Students' value perceptions were hypothesized to increase from pre-test to immediate post-test and from pre-test to 2-week delayed post-test for students in the VR-E Group. Four types of value perceptions were measured in this study: overall task value (OTV), endogenous utility value (ENDUV), exogenous utility value (EXOUV), and intrinsic value (INT). As expected, there were no effects of the GS-E Intervention or the Control Condition observed on any of the value perception measures. The VR-E Intervention, on the other hand, was found to positively impact measures of OTV, ENDUV, and INT immediately after the intervention. Measures of effect size also suggested that the immediate impact of the VR-E Intervention on ENDUV was large (.82 standard deviation increase), whereas, the immediate impact on OTV (.46 standard deviation increase) and IV (.39 standard deviation increase) were medium. These intervention effects were not found to attenuate significantly 2 weeks after receiving the intervention (even though the means for each variable decreased from immediate post-test to 2-week delayed post-test). Interestingly, the effect of the VR-E Intervention on OTV and INT was not statistically significant from pre-test to 2-week delayed post-test, whereas, the effect of the VR-E Intervention on ENDUV from pre-test to 2-week delayed

post-test was statistically significant. Furthermore, the effect size of the VR-E Intervention on ENDUV from pre-test to 2-week delayed post-test was meaningful (.56 standard deviation increase). Finding also suggested that the VR-E Intervention did not impact EXOUV. Therefore, the hypotheses regarding the effect of the VR-E Intervention on value perceptions were not supported for EXOUV, were partially supported for OTV and IV, and were fully supported for ENDUV.

As can be seen in Figures 2, 3 and 4, the pattern of results was similar for OTV, ENDUV, and IV. Students in the VR-E Group increased from pre-test to immediate post-test, decreased from immediate post-test to 2-week delayed post-test, but did not decrease back to, or below, their original pre-test scores. One reason that the hypotheses were only partially supported for OTV and IV could be because there was not sufficient power (i.e., a large enough sample size) to detect significance of the small increase that was observed on these variables from pre-test to 2-week delayed post-test for the VR-E Group. The effect sizes for these measures were small but potentially meaningful (.26 standard deviation increase for OTV, .18 standard deviation increase for IV).

Overall, these results suggest that the VR-E Intervention helped students to increase the overall importance they placed on tasks in their introductory statistics course, the value they placed on developing statistical knowledge and skills for the attainment of their future goals, and their intrinsic enjoyment of learning statistics. Furthermore, the VR-E Intervention was found to have relatively stronger and longer-lasting positive effects on the importance students placed on developing their statistical knowledge and

skills for the attainment of their future goals compared to the other value perceptions that were measured.

The VR-E Intervention may have had stronger and longer-lasting impacts on students' endogenous utility value because developing statistical knowledge and skills can, indeed, be useful in many situations and this may have rung true with students. For intrinsic value, on the other hand, students may have realized over the 2-week delay that, despite the strategies they could use to make statistics more interesting and enjoyable, there are certain aspects about learning statistics that are not fun for them. The measure of overall task value used in this study combined items related to attainment value, utility value, and intrinsic value. The null effect from pre-test to 2-week delayed post-test for this measure may have had more to do with students' ratings on the intrinsic value items than their ratings on the utility value items.

The null findings related to exogenous utility value could possibly be because the VR-E Intervention was not focused on conveying to students the importance of passing introductory statistics and performing well in the course. Alternatively, it was focused on conveying to students the importance of learning and mastering statistics as well as making statistics more enjoyable and interesting.

My master's thesis results on value perceptions were similar to the results presented here. In my master's thesis the value reappraisal intervention was found to affect students' overall task value and endogenous utility value. Furthermore, the effect of VR-E on endogenous utility value was found to be stronger and relatively longer-lasting than it was for overall task value. Therefore, these results were consistent across

studies. However, in my master's thesis there was no effect of VR-E on intrinsic value. In this study, however, an immediate effect of VR-E on intrinsic value was observed. The value reappraisal intervention used in this study included three additional examples about ways students could increase their intrinsic value for a task and also included an additional activity that asked students to choose two strategies they could use to increase their intrinsic value for statistics. This enhancement may have helped students to increase their intrinsic value for statistics.

Continued Interest

There were two measures of continued interest used in this study: 1) Intentions for Continuing to Learn Statistics (ICLS); and 2) Choice-Behaviors to Learn Statistics (CBLS). The data in this study supported the hypotheses related to ICLS but did not support the hypotheses for CBLS. The GS-E Intervention and Control Condition showed no impact on the ICLS measure. On the other hand, students in the VR-E Group made significant gains on ICLS immediately after the intervention as well as 2 weeks later. Furthermore, the effect sizes for these gains were fairly large. From pre-test to immediate post-test students made a .70 standard deviation increase and from pre-test to 2-week delayed post-test students made a .69 standard deviation increase (this shows that the immediate effect was almost fully maintained after 2 weeks). These results suggest that the VR-E Intervention was successful at positively impacting students' intentions to continue learning statistics after their introductory statistics course was over. In addition, this effect held up 2 weeks after receiving the VR-E Intervention. This measure was not

used in my master's thesis so these results help to extend findings on the positive impact of the VR-E Intervention to students' intentions to continue learning statistics.

For the CBLS measure, there were no significant differences found between students in the Control Group, the GS-E Group, or the VR-E Group. Therefore, the VR-E Intervention was not found to impact students' choice behaviors to access the statistics website links that were posted on the course webpage. In my master's thesis the VR-E Intervention was found to impact the CBLS measure. It is confusing why this finding was not replicated in this study. Possibly the finding observed in my master's thesis was a spurious effect. In my master's thesis, this measure was only given to students in Study 2; therefore, the ability to replicate this finding had never been examined until this study. In both studies very few students accessed the website links: 10 out of 74 accessed both websites in my master's thesis; and 10 out of 88 accessed Website A and 9 accessed Website B in this study.

Self-efficacy Beliefs

The VR-E Intervention showed no impact on students' self-efficacy beliefs. This finding was interesting theoretically because it showed that increasing students' value perceptions was not paralleled by an increase in students' self-efficacy beliefs. Historically, expectancy x value theory suggested that value perceptions and expectation beliefs were inversely related (Atkinson, 1964). Current theory and research on expectancy-value theory, however, has shown that value perceptions and expectation beliefs are positively related (Wigfield & Eccles, 2000). There is not, unfortunately, not much experimental education research on the causal relationships between these two

constructs. This research showed that there was not a direct effect of the VR-E Intervention on self-efficacy beliefs despite there being a direct effect of the VR-E Intervention on value perceptions. Future research needs to examine the indirect effect of the VR-E Intervention on self-efficacy beliefs through value perceptions in order to more thoroughly examine the causal effect of value perceptions on self-efficacy beliefs.

Exam Performance

The VR-E Group was found to have significantly higher post-intervention exam scores than the GS-E Group (adjusting for pre-intervention exam scores) but neither group had significantly different post-intervention exams scores than the Control Group. This finding was not expected given past research that has suggested that goal setting and self-evaluation can positively impact task performance (Bandura, & Schunk, 1981; Kitsantas, Reiser, & Doster, 2004; Latham & Seijts, 1999; Schunk, 1996; Schunk & Ertmer, 1999; Schunk & Swartz, 1993). This finding was also contrary to research suggesting that self-efficacy beliefs are stronger predictors of achievement compared to value perceptions (Joyce & Farenga, 2000; Meece, Wigfield, & Eccles, 1990; Wigfield & Eccles, 1992, 2000). Nonetheless, research has reported positive relationships between value perceptions and achievement (Eccles, 2005; Simpkins, Davis-Kean, & Eccles, 2006; Wigfield & Eccles, 1992). Possibly helping students to place greater importance on learning statistics motivated them to study statistics, which in turn facilitated their exam performance. Expectancy-value theory suggests that students are motivated towards tasks that they perceive as being important for them (Atkinson, 1964; Eccles, 2005; Eccles, et al., 1983; Heckhausen & Kuhl, 1985). The VR-E intervention may have also facilitated

students' exam performance by guiding them in thinking about the application of statistics in everyday life and across different occupations. Thinking about how statistics applies to real-life situations could potentially facilitate students' understanding of statistical concepts and help to develop their statistical thinking and reasoning skills. However, it is important to remember that this did not seem to impact their performance sufficiently to surpass the performance of the Control Condition participants.

Some Implications of the Study Findings

Overall, these findings add causal support to theory and research suggesting that value perceptions and continued interest can be modified through interventions (Pintrich, 2000, 2004; Wolters, 1998, 2003). These results are promising because they suggest that students' pre-existing value perceptions about learning statistics and their intentions to continue learning statistics can be improved by presenting them with messages and guiding them in using self-regulatory strategies to explore the value of learning statistics.

Previous theory and research has suggested that providing students with purposes and reasons for engaging in academic tasks can help them to place more value on those tasks (Brophy, 1999; Hofer, 2002; Latham, Erez, and Locke, 1988). Eccle's conceptualization of the components of the value construct (attainment, utility, intrinsic, and cost) was used to help structure the arguments presented in the VR-E Intervention. Using Eccle's framework may have contributed to the success of the VR-E Intervention and could be important to consider when crafting an argument about the importance of academic tasks.

This study also helps to provide support for theory and research that has suggested that students can actively use strategies to increase the value they place on academic tasks (Pintrich, 2000, 2004; Wolters, 1998, 2003). Wolter's (1998) work in this area showed that students report using strategies to increase the value they place on their academic tasks. The current study adds to this line of research by showing that an intervention focused on guiding students in using strategies (brainstorming, generating rationales, imagining, and contrasting pros and cons) can lead to increases in students' value perceptions and also increase their intentions to continue learning statistics.

The effect of the VR-E Intervention on exam performance was unexpected. Group differences were only observed between the VR-E Group and GS-E Group. Future research needs to attempt to replicate this effect and examine if benefits can be observed relative to a control group. While this finding is only tentative, it nonetheless suggests that the Value Reappraisal Intervention might have the potential to positively impact students' learning and achievement in a course.

Limitations

All studies have limitations and this dissertation study was no exception. One limitation of this study was the generalizability of study findings to different population and contexts. This study was focused on undergraduate female students' who were for the most part traditionally aged. Furthermore, this study was conducted in an introductory statistics course offered through an educational psychology department at a 4-year public university. The generalizability of these results to men, to non-traditionally aged adult

college students, to K-12 students, and to students enrolled in different statistics courses are limited.

Another limitation of this study was that students were nested within two sections of an introductory statistics course, each with a different instructor. While stratified random assignment to interventions within each section allowed for meaningful comparisons between intervention groups, a study with a larger number of sections (10 at the least) would allow for between class variance to be modeled hierarchically with participants at a lower level. This would allow for interactions between the interventions and characteristics of the course and instructor to be examined.

The longitudinal design of this study allowed intervention effects to be examined on self-report measures 2 weeks after the intervention. This study was limited in examining the maintenance of these effects over a longer period of time. Because some of the effects of the VR-E Intervention on value perceptions were found to decrease in magnitude from immediate post-test to 2-week delayed post-test, it is important to examine the maintenance of these effects over a longer period of time.

In addition, the design of the interventions and the impact, and success, of each of the components has not yet been investigated from the perspective of their instructional design. There may also have been confounding from communications between participants in different groups.

Future Research

While VR had positive impacts on students' value perceptions and continued interest, it is unclear what specific mechanisms within the intervention contributed to

student gains. Students were asked to use a variety of value reappraisal strategies (e.g., brainstorming attainment, utility, and intrinsic reasons for learning course content, generating rationales, imagining experiencing benefits resulting from learning course content, and contrasting benefits with costs of task engagement) and these strategies could have differentially impacted students' value perceptions and continued interest. A systematic investigation into the effects of different value reappraisal strategies on students' value perceptions, continued interest, and achievement is an important area for future work. Furthermore, the messages students received about the reasons learning statistics might be important for them could have contributed to the positive effects of the VR-E Intervention on study outcomes. The main and interactive effects of persuasive messages and value reappraisal strategies also need to be examined in future studies.

In both my master's thesis and this dissertation study, the value reappraisal interventions were found to be effective at impacting the importance students place on learning course material. The framework used in this intervention needs to be examined with other populations and in other contexts. For example, designing and evaluating a value reappraisal intervention for at-risk students in developmental math courses could be a fruitful area of research because these students have been shown to struggle in math courses. It would also be interesting to design and evaluate a value reappraisal intervention designed to help students positively reappraise the importance of going to college. Such an intervention could be useful for high school students who are unsure about whether or not they want to go to college as well as entering college students who are skeptical about the utility of college for them personally.

It was difficult to assess the differential benefits of the GS-E Intervention and VR-E Intervention because the GS-E Intervention was not robust. Future research needs to investigate modified goal setting and self-evaluation interventions as well as different implementation strategies and measurement techniques. For example, having students use goal setting and self-evaluation strategies over a series of tasks across an entire semester might be more effective. If and when such an intervention is found to be successful at impacting educational outcomes in introductory statistics, it could then be compared to the VR-E Intervention to examine the potential differential benefits of these interventions on study outcomes.

Conclusion

Results from this study suggested that the VR-E Intervention helped students to both increase the importance they placed on developing statistical knowledge and skills for the attainment of their future goals and to strengthen their intentions to continue learning statistics on their own. These effects were found to be fairly large and were also found to hold up 2 weeks after the intervention. The VR-E Intervention was also found to help students both increase the overall value they placed on learning statistics and strengthen their enjoyment and interest in statistics. However, these effects were only moderate and did not hold up after 2 weeks. In addition, some tentative evidence was found that the VR-E Intervention may help to facilitate students' performance on course exams but these benefits were only observed in comparison with the GS-E Group, not the Control Group.

The VR-E Intervention could potentially be used in introductory statistics courses to help increase students value perceptions and continued interest. It could also serve as a model for instructing students about the importance of course material in other academic domains.

Theoretically, this research is important because it helps to extend research on self-regulation to the regulation of students' value perceptions. Furthermore, this study provides a useful framework to guide other researchers in investigating the effects of persuasive messages and value reappraisal strategies on students' value perceptions, continued interest, and achievement in math, science, and statistics courses.

Appendix A: Self-report Dependent Measures (45 items total)

Note. The measures below were administered online using Survey Monkey. A 7-point Likert-type scale (1 "Strongly Disagree," 2 "Disagree," 3 "Disagree a Little," 4 "Undecided," 5 "Agree a Little," 6 "Agree," 7 "Strongly Agree)" was used for all items except items 40-45.

Instructions: Hello and welcome to Survey 1 of The Statistics Project. The following survey items are about your attitudes, beliefs, goals, and experiences related to your Introductory Statistics Course (EDP371). The usefulness of our research depends upon you carefully and honestly responding to each survey item. Please take your time and answer the items as best as you can. You must complete the entire survey now. Your responses will not be saved if you exit the survey in the middle.

You are to read each statement and rate yourself according to how well the statement describes you, not in terms of how you think you should be or what others do.

Self-efficacy for Course Tasks (SECT)

1. If I have enough time, I can do most of the work in my EDP371 statistics course.
2. Some of the work in my EDP371 statistics course is too difficult for me.
3. I am certain I can master the skills that are taught in this course.
4. I know that I can do a good job on the exams in EDP371.
5. No matter how hard I try, there is some content in EDP371 that I will never understand.

6. I know I can do even the most difficult work in EDP371.
7. If I don't give up, I can do almost all the work in this course.
8. I am certain that I can do a good job on the assignments in this course.

Overall Task Value (OTV)

9. I think I will be able to use what I learn in my EDP371 course in other courses.
10. It is important for me to learn the course material in this course.
11. I am very interested in the content area of this course.
12. I think the material in this course is useful for me to learn.
13. I like the subject matter in my EDP371 course.
14. Understanding the subject matter of this course is very important to me.

Endogenous Utility Value (END-UV)

15. I will use the information I learn in EDP371 in other classes I will take in the future.
16. What I learn in EDP371 will be important for my future occupational success.
17. I will not use what I learn in EDP371.
18. I will use the information I learn in EDP371 in the future.

Exogenous Utility Value (EXO-UV)

19. The grade I get in EDP371 will not affect my ability to continue on with my education.
20. The grade I get in EDP371 will not be important for my future academic success.
21. The grade I get in EDP371 will affect my future.
22. I must pass EDP371 in order to reach my academic goals.

Intrinsic Value (IV)

23. I enjoy doing my EDP371 coursework very much.
24. The coursework in EDP371 is fun to do.
25. I think the coursework in EDP371 is boring.
26. The coursework in EDP371 does not hold my attention at all.
27. I would describe the coursework in EDP371 as very interesting.
28. I think the coursework in EDP371 is quite enjoyable.
29. While doing the coursework in EDP371, I think about how much I enjoy it.

Intentions to Continue Learning Statistics (ICLS)

30. After this course is over, I do not intend to continue learning more about statistics on my own.
31. If taking another statistics course was not required, I would still want to take another statistics course.
32. After my EDP371 statistics course is over, I will not search for information on the internet related to statistics.
33. After EDP371 is over, I intend to continue reading about statistics.
34. After this course is over, I intend to learn about statistics on my own.
35. After my EDP371 statistics course is over, I have no intention of discussing statistical concepts with others.

Course Effort (CE)

36. Over the past two weeks, I put a lot of effort into my EDP371 course.
37. Over the past two weeks, I did not try very hard to do well in EDP371.
38. Over the past two weeks, I did not put much energy into my EDP371 course.
39. Over the past two weeks, I tried very hard to do my coursework for EDP371.

Study Hours (SH)

40. Over the past two weeks, how many hours did you spend studying or doing work for EDP371?

Office Hour Visits (OHV)

41. Over the past two weeks, how many times did you visit your EDP371 professor or teaching assistant during office hours or by appointment?

Class Absences (CA)

42. Over the past two weeks, how many classes did you miss in your EDP371 course?

43. For each EDP371 class you missed over the past two weeks, explain why you missed that class? (If you did not miss a class, type "NA").

Self-efficacy for Exam Performance (SEEP)

44. Please indicate the highest percentage score you feel completely certain (100% sure) you can achieve on the next exam in your EDP371 course. Type your response (from 0 to 100) in the box below.

Self-efficacy for Reaching Learning Objectives (SERLO)

45. Please indicate the highest percent of learning objectives for your next EDP371 exam you feel completely certain (100% sure) you can reach before taking the exam. Type your response (from 0 to 100) in the box below.

Appendix B: Demographic and Student Experiences Survey

[Items were administered using Survey Monkey. Likert-type items were rated on the following 7-point scale: 1 (Strongly disagree), 2 (Disagree), 3 (Disagree a little), 4 (Undecided), 5 (Agree a little), 6 (Agree), 7 (Strongly agree). A text box was used for items requiring an open-ended text or numeric response. Check boxes were used for items with categorical response sets].

1. What is your sex?
    a. Male
    b. Female
2. What is your ethnic identification?
    a. American Indian or Alaska native
    b. Asian
    c. Black or African American
    d. Hispanic or Latino
    e. Native Hawaiian or Other Pacific Islander
    d. White or Caucasian
    e. Other
3. What is your year in college?
    a. First Year
    b. Sophomore
    c. Junior
    d. Senior
    e. Graduate Student
4. Have you declared a major?
    a. Yes
    b. No
5. What is your major, or if undecided, what is your intended major?
6. What is the primary reason why you took EDP 371 Introduction to Statistics?
7. Why did you take EDP 371 Introduction to Statistics? (check all that apply)

a. It is required for my degree.
b. It is a prerequisite for entry into a program or school I want to be in.
c. It fulfills an elective requirement for my degree.
d. I needed more credit hours this semester.
e. It fit well with my schedule.
f. It seemed better than the other courses I was choosing between.
g. I thought it would be an easy course.
h. I though it would challenge me and I like that.
i. To learn more about statistics.
j. To help prepare me for a job.
k. To help prepare me for graduate school.
l. I was interested in it.
m. I thought it would be fun.
n. I thought it was an important subject to learn about.
o. Other (please specify)

8. What is your age?
9. How many statistics courses do you intend to take in the future?
10. Please type into the number box what percent (from 0 to 100) of the computerized workbook you completed.
11. Please type into the number box what percent (from 0 to 100) of the reading passages in the computerized workbook you read.
12. Please type into the number box what percent (from 0 to 100) of the activities in the computerized workbook you completed.
13. I was attentive while completing the computerized workbook.
14. I tried to use the computerized workbook to help me improve.
15. I did not take the computerized workbook very seriously.
16. I was honest in my responses to the activities in the computerized workbook.
17. I found that completing the computerized workbook was useful to me.
18. I enjoyed completing the computerized workbook.

19. I thought that completing the computerized workbook was a waste of my time.
20. I would recommend other students to complete the computerized workbook.
21. Please describe what you liked most about the computerized workbook.
22. Please describe what you liked least about the computerized workbook.
23. Please explain what you think could be done to make the computerized workbook more useful for you personally.

Appendix C: Enhanced Goal Setting Intervention (GS-E)

Instructions

This electronic workbook is designed to help you set useful goals so that you can be more successful in your EDP371 introductory statistics course. Please read through the entire workbook from beginning to end and complete every activity along the way. Type your responses to the activities in the spaces provided (marked in green). At any time if you have a question, raise your hand and the facilitator will come over to help you. Please do not rush and take as much time as you need. The usefulness of our research and the benefits it may bring to you and statistics students in the future depends upon you carefully and honestly reading and responding to the material presented below.

Introduction

Being successful at anything involves setting useful goals. Consider the 1999 - 2005 Tour de France winner, Lance Armstrong, who fought a difficult battle with cancer. Without setting useful goals, would he have been able to overcome a life-threatening disease and then go on to win one of the most grueling events in sports for seven years in a row? No matter what you set out to do, the journey begins with a goal. You need to know what you want to achieve and the steps you need to take to achieve it. You must also be committed to doing the work necessary for achieving your goal.

Many students enter statistics courses without a clear idea of how to set useful goals to help them learn their course material. Furthermore, many students have never actually taken the time to write out their learning goals for a course. Research has demonstrated time and again that poor goal setting skills play a large role in keeping otherwise successful students from performing well in their statistics courses. Using the information, suggestions, and strategies presented in this workbook, you can improve your goal-setting strategies, become more motivated and achieve at a higher level in your EDP371 introductory statistics course.

Passage 1

<u>What is a Goal and Why is it Important to Set Useful Goals for EDP371?</u>

Characteristics of Students Who Set Useful Goals for EDP371 Statistics

In this section, we will identify what you already know about students who set useful goals for their EDP371 statistics course. We will also discuss what research and other students have to say about such students.

We will begin by examining your opinions about students who set useful goals for EDP371.

Activity 1a:

Write two examples of how students who set useful goals for their EDP371 statistics course might feel, think, and work toward successfully completing their coursework.

Example 1:

Example 2:

Now, let's look at the findings from research and the reports of students who set useful goals for their EDP371 statistics course. What do they say about the ways these students feel, think, and behave?

- Students who set useful goals in EDP371 are generally more motivated towards completing their course-related activities.
- They know what they want to get out of their statistics course and work hard to achieve it.
- They have a clear idea about what to study, how to study, when to study, and where to study for EDP371.
- Students who set useful goals hand in assignments on time and turn in good work.
- They see how coursework helps them to fulfill their personal and academic goals.
- Students who set useful goals for their EDP371 statistics course are able to focus and maintain their attention during class and while completing assignments.
- They use effective learning strategies and study skills to learn their course material and to reach their course goals.

Characteristics of Students Who Do Not Set Useful Goals for EDP371 Statistics

Now, let's look at students who do not set useful goals for their EDP371 statistics course. We want you to state some of your opinions about such students in the activity below.

Activity 1b:

Write two examples of how students who do not set useful goals for their EDP371 statistics courses might feel, think, and work toward successfully completing their coursework.

Example 1:

Example 2:

Now, let's look at the findings from research and the reports of students who do not set useful goals for their EDP371 statistics course. What do they say about the ways these students feel, think, and behave?

- Students who do not set useful goals for their EDP371 statistics course may have low motivation for learning the course material.

- They may do poorly on assignments and tests because of not having a good study plan.

- They may turn in assignments late, or not at all, because they don't have goals that keep them on track and guide them about what to study, how to study, when to study and where to study.

- Students who do not set useful goals for their EDP371 statistics course may find it difficult to concentrate and stay focused during class and when studying.

- They may have difficulty seeing how their coursework is important for achieving their personal and academic goals.

- They may not put forth the effort necessary to succeed in EDP371.

What are Useful Goals?

Setting useful goals for your EDP371 statistics course involves many things such as:

- Setting goals for what you want to learn and the grade you want to get in EDP371. For example, do you want to ace the course or is a B or C your goal?

- Setting short-term goals that help you to reach your long-term goals for EDP371. Setting short-term goals are like mile markers on the highway; they help you to see the progress you are making toward reaching a long-term goal. For example,

you can set weekly study goals in EDP371 that will help you learn the course material for the upcoming exam.

- Setting goals focused on the methods and strategies that you will use to learn course concepts and build course-related skills. What types of study strategies or study skills (e.g., summarizing what you read, writing out a procedure from memory) will you use to reach your goals for EDP371?

- Setting goals for EDP371 that are challenging yet realistic. When we set goals that are not challenging it is easy to get bored or distracted from our schoolwork. Setting goals that are too challenging can lead us to give up and stop trying.

- Setting goals with specific and measurable outcomes so you know when you have accomplished them. For example, saying that you will study for EDP371 more often is not specific and measurable. But, saying you will read the first 3 sections of Chapter 6 by next Friday is measurable.

- Setting goals that specify when you will work towards achieving them. We all have many goals and we need to find time within our schedules to reach them. Setting useful goals for EDP371 involves setting aside time in your schedule to study statistics and working towards reaching your EDP371 goals.

How well do you set useful goals for your EDP371 introductory statistics course?

Activity 1c:

A. Explain (at least 2-3 sentences) how well you set useful goals for your EDP371 introductory statistics course (you can use the above description of what useful goals are to help structure your answer)?

Type Here:

Goal Setting: An Important Factor in Succeeding in your EDP371 Course

Being successful at anything involves setting useful goals. Your goals for your EDP371 introductory statistics course directly impact your motivation and success in the course. While it is important to have goals for what grades you want to earn, it is even more important to set goals for the course material you want to learn and master. You will be more likely to put forth the effort needed to complete your coursework if you set useful goals for learning course content and developing course skills. You also have to track your progress towards reaching those goals over time.

The reading passages and activities in this workbook are designed to help you improve your goals and goal setting strategies for EDP371 so that you can be more effective and efficient in your studies. This begins with figuring out what course material you need to learn and setting goals focused on the methods and strategies that you will use to learn that material. It also involves revising these goals so that they are challenging yet realistic, specific and measurable, and state when you will work on them. So let's get started.

Passage 2

What Type of Goals Should I Set for EDP371?

Goal Setting for EDP371

The purpose of EDP371 is to help you learn information about statistics and develop skills in statistical problem solving, thinking and reasoning. In order to do this, it is important that you set specific goals for learning course concepts and skills and monitor your progress toward reaching these goals. The information and activities below will help you: 1) set 8 goals focused on what to study and how to study in order to reach 2 of the learning objectives in EDP371; 2) revise these goals so that they are challenging yet realistic and specific and measurable, 3) revise these goals again so that they state exactly when over the next 2 weeks you will work towards reaching them; and 4) monitor and evaluate your progress towards reaching each of these 8 goals for EDP371.

Useful goals for learning statistics are focused on the methods and strategies that you will use to learn a concept, master a skill, or reach a learning objective. These goals help you to identify what to study and how to study it.

What to study

Your goals need to direct you to the course material or information sources that you will need in order to learn more about a concept, skill or learning objective.

For example, you could set goals focused on:

- Completing a reading assignment.
- Completing a homework assignment.
- Answering practice problems from the course textbook, a practice test, or handout.
- Reviewing class notes.

- Studying class handouts.
- Accessing supplemental sources (e.g., Internet sources, books recommended by the professor, etc.).
- Visiting the professor or teaching assistant outside of class.
- Attending study groups.

How to study

It is also important that your goals direct you in what learning strategies and study skills to use in order to learn and retain the course material you decide to study.

For example, you could set goals that are focused on learning strategies and study skills such as:

- Summarizing what you read or studied in your own words.
- Explaining to a friend what you have read or learned.
- Writing out major ideas and important points from what you just read or studied.
- Writing out the steps of a method or procedure from memory.
- Explaining, in your own words, why each step of a method or procedure is important and what it is accomplishing.
- Writing out answers to learning objectives in your own words from memory.
- Making a diagram, chart, or concept map of the concept(s), skill(s), or procedure(s) you are trying to learn.
- Explaining, in your own words, how what you are learning is similar to something else that you have learned or studied in the past.
- Making a list of questions you have about the material you are trying to learn.

Setting Goals for What to Study and How to Study
In order to learn a concept, skill, or reach a learning objective, you need to set goals that direct you in both what to study and how to study.

For example, if one of your EDP371 learning objectives was: “Be able to define, calculate, and know when to use the three measures of central tendency (i.e., mean, medium, and mode)” you could set the following goals to help you reach that learning objective.

What to study:

- I will read the section in my textbook on measures of central tendency.
- I will visit my professor during office hours with a list of questions about measures of central tendency.

How to study:

- Without looking back at my textbook, I will write out at least 10 important points related to measures of central tendency.
- Without looking back to the book for the answer, I will answer each part of the learning objective on measures of central tendency.

Another example: If you wanted to reach the following learning objective for your statistics course: “be able to list and perform each of the steps involved in testing a hypothesis,” you could set the following goals.

What to study:

- I will review last week’s notes on hypothesis testing.
- I will complete the homework assignment the instructor handed out on testing hypotheses.

How to study:

- From memory, I will write out a detailed description of each step of testing a hypothesis.
- I will make a table with the name of each step of testing a hypothesis in the rows and two examples of me doing each step in the next two columns.

Before you set goals for your EDP371 statistics course, you first need to think about the information that you need to learn and the skills you need to develop. Your EDP371

instructor has made this easy for you by providing you with learning objectives. The following activity will help you set goals for reaching 2 of the learning objectives for your next exam in EDP371.

Activity 2:

Step 1: Copy and paste below 2 learning objectives for your upcoming EDP371 exam. Please choose learning objectives that you will be able to work towards reaching over the next 2 weeks. To view the learning objectives for your upcoming exam, type in "webspace.utexas.edu/aceetw/www" into your web browser. Click on the file labeled with your instructor's last name, unique number and the word "objectives" (e.g., "Pituch_10480_Objectives" or "Vaughn_10485_Objectives"). You can also view your course schedule by clicking on the file with the word "course schedule" in it. Please raise your hand and ask for help if you are having any trouble.

Learning Objective A:

Learning Objective B:

Step 2: For Learning Objective A above, set 4 goals that will help you reach that objective. Two of your goals should address *what you will study* and the other 2 should address *how you will study*. Because you will monitor your attainment of these goals over the next 2 weeks, the goals you set must be attainable within **THE NEXT 2 WEEKS.**

What you will Study for Learning Objective A:

Goal 1:

Goal 2:

How you will Study for Learning Objective A:

Goal 3:

Goal 4:

Step 3: For Learning Objective B above, set 4 goals that will help you reach that objective. Two of your goals should address *what you will study* and the other 2 should address *how you will study*. Because you will monitor your attainment of these goals over the next 2 weeks, the goals you set must be attainable within **THE NEXT 2 WEEKS.**

What you will Study for Learning Objective B:

Goal 5:

Goal 6:

How you will Study for Learning Objective B:

Goal 7:

Goal 8:

Passage 3

How can I revise my EDP371 goals so that they are more useful?

Revising Your Goals for EDP371

The goals you set in the activity above may need to be revised so that they are more useful. Two of the requirements of a useful goal are that they are: 1) specific and measurable; and 2) challenging yet realist.

Setting Specific and Measurable Goals for EDP371

To make a goal useful, one requirement is that it must be **specific and measurable**.

In order for a goal to be specific and measurable, you need to define exactly what you want to achieve so that later you will be able to judge objectively, without question, whether or not you reached your goal. Ask yourself, “If I bet my friend that I could reach this goal, could we later be able to tell who won the bet?”

Look at the 8 goals that you listed above. Do your goals refer to working on assignments without specifying how much of the assignment you want to get through? Do your goals contain words like "some" or "more" or "better"? If so, these goals are too vague or general, and they need to be revised so that they are specific and measurable. To make your goals specific and measurable, you need to replace any ambiguous words with numbers or more specific terms. You will revise your goals in the activity below so DO NOT change the goals you typed above.

For example:

- Instead of saying, "I will read the textbook on this learning objective," you could say, "I will read the first 5 sections of Chapter 9 from the textbook."

- Instead of saying, “I will work through some of the practice problems related to calculating z-scores,” you could say “I will complete all 7 of the practice problems that the professor handed out on calculating z-scores.”

- Instead of saying, “I will visit the professor more often during office hours,” you could say, “I will visit the professor next Thursday during office hours with a list of questions I have about the differences between nominal, ordinal, interval and ratio scales.”

Summary of Specific and Measurable Goals

- Remember, to be useful, a goal has to be specific and measurable so that you know exactly what you want to achieve.

- There are many things you can be doing at any point in time. Specific and measurable goals can help you stay focused on completing your EDP371 coursework so you also have time for other things.

- Goals also need to be specific and measurable so you can judge when you have completed or reached the goal. If there were no clear way to tell if you reached a goal, you would not know when to stop working on it and begin celebrating your accomplishments.

Setting Challenging yet Realistic Goals for EDP371

To make a goal useful, another requirement is that it must be **challenging yet realistic**.

Look at the goals that you listed above. Are the goals you listed challenging yet realistic? It is important that your goals are challenging yet realistic because such goals will help motivate you to do your very best in the course. If your goals are too difficult for you and unrealistic for you to reach, they can make you feel overwhelmed and helpless and make you want to give up. On the other hand if your goals are not challenging enough, they will bore you and they won’t push you to do your very best in the course. This is why you need to make your goals challenging yet realistic.

Again, think about who YOU are. The goals that you set may be different from the goals that another student sets. What's challenging to you may be too challenging or not challenging enough for someone else. That's OK because everyone is different.

Also, be aware that it is very common for students to overestimate what they think they can accomplish. That is, students are more likely to set over-challenging and unrealistic goals. Therefore, you might want to lower the difficulty of your goals so that they are more realistic for you to reach.

For example:

- Instead of saying, “I will answer all of the practice problems on measures of variability from Chapter 4,” you could make your goal more realistic by saying, “I will answer half of the practice problems on measures of variability from Chapter 4.”

- Instead of saying, "I will review my notes from the first class on hypothesis testing,” you could make your goal more challenging by saying, “I will review my notes from each of the 2 classes on hypothesis testing.”

- Instead of saying, “I will write out the answer to all 3 parts of this learning objective in my own words,” you could make your goal more realistic by saying, “I will write out the answer to the first 2 parts of this learning objective in my own words.”

Summary of Challenging yet Realistic Goals

- Remember, to be useful, a goal has to be challenging, but it also has to be realistic.

- A goal needs to be challenging so it pushes you to do your very best.

- It has to be realistic so that you don’t feel over-whelmed and want to give up.

- Students tend to overestimate what they can accomplish so you may want to lower the difficulty of your goals so that they are more realistic for you to reach.

Revising your goals for EDP371
Using the information above about the useful characteristics of a goal, revise your goals so that they are:

- **Specific and Measurable**

- **Challenging yet Realistic**

Activity 3:

Step 1: Revise, if necessary, Goals 1, 2, 3 and 4 so that they are: 1) specific and measurable; and 2) challenging yet realistic. You can copy and paste your goals from Activity 2 to the appropriate spaces below and then revise those goals. Even if your goals do not require revision, still paste them below.

First Revision of Goal 1:

First Revision of Goal 2:

First Revision of Goal 3:

First Revision of Goal 4:

Step 2: Revise, if necessary, Goals 5, 6, 7 and 8 so that they are: 1) specific and measurable; and 2) challenging yet realistic. You can copy and paste your goals from Activity 2 to the appropriate spaces below and then revise those goals. Even if your goals do not require revision, still paste them below.

First Revision of Goal 5:

First Revision of Goal 6:

First Revision of Goal 7:

First Revision of Goal 8:

Passage 4

Stating When You Will Work Towards Your Goals for EDP371

To make a goal useful, the final requirement is that it must **state when** you will work towards reaching it.

The goals you set above for EDP371 must have a clear starting day, date, and time of day (e.g., Thursday, September 4th at 1pm) so you know when to begin working toward these goals. The start times that you choose for your goals must be **within the next 2 weeks** because you will be working on and evaluating your progress towards these goals over the next 2 weeks.

Stating when you will work towards your goals for EDP371 involves using your time management skills. You need to think about your schedule over the next 2 weeks and the times you have available to work towards your EDP371 goals. When you choose a specific day, date, and time to work on your EDP371 goals make sure you reserve a long enough amount of time so that you can reach your goals. You should also choose a time of day when you are alert and able to focus on your coursework.

It is also important that you state when you will work on your goal at the beginning of the goal, not at the end. Use the following statement: "On (specify day, date, time), I will (specify goal)." Research has suggested that phrasing your goals this way can greatly increase the likelihood that you will reach your goal within the time you specified.

For example,

- Instead of saying, "I will read the first section of Chapter 4 on Monday, July 18th at 9pm," you could say, "On Monday, July 18th at 9pm, I will read the first section of Chapter 4."

- Instead of saying, "Without referring back to the book, I will answer 3 practice problems on measures of central tendency from Chapter 3" you could say, "On Tuesday, January 23rd at 2:30pm, without referring back to the book I will answer 3 practice problems on measures of central tendency from Chapter 3"

- Instead of saying, "I will make a table of the situations where I should and should not use z-scores," you could say, "On Saturday, May 4th at 9am, I will make a table of the situations where I should and should not use z-scores"

Summary of Stating When You Will Start Working Towards Your EDP371 Goals

- Remember, to be useful, a goal must have a clear start day, date, and time of day (e.g., Monday, September 4th at 8pm).

- The day, date, and time you specify in your goals needs to be within the next 2 weeks because you will be evaluating your progress towards reaching your goals over the next 2 weeks.

- A start time tells you when you must begin working towards your goal. Without a clear starting time, it is easy to put off tasks and wait to the last minute to do them or not do them at all.

- Stating when you will work towards your goal involves using your time management skills. You need to look over your schedule for the next 2 weeks and

find available times when you can towards your EDP371 goals. You need to make sure you give yourself enough time to reach your goals and you should also choose times of the day to study when you are alert and able to focus on your coursework.

- State when you will complete your goals at the beginning of the goal using the following phrase: On (specify day, date, time), I will (specify goal). This will help you to reach your goals on time.

Revising your goals for EDP371
Using the information above about the useful characteristics of a goal, revise your goals so that they:

- **State when you will work on your goals.**
- **Contain a start time that is within the next 2 weeks.**
- **Phrased using the statement: On (specificy day, date, time), I will (specify goal).**

Activity 4:

Step 1: Below, list all days, dates, and times (e.g., Monday, October 20th, 5pm-11pm; Tuesday, October, 21st, 8am-9am, etc.) that are available for you to work towards reaching your EDP371 goals. If you need to view a calendar, double click on the time displayed at the bottom right of your computer screen. Also, if you have a personal calendar with you feel free to use it.

List all available days, dates, and times over the next 2 weeks:

Step 2: Revise, if necessary, Goals 1, 2, 3 and 4 so that they: 1) state when you will work on your goal; 2) contain a start time that is within the next 2 weeks; and 3) phrased using the following statement: "On (specify day, date, time), I will (specify goal)".You can copy and paste your goals from Activity 3 to the appropriate spaces below and then revise those goals. Even if your goals do not require revision, still paste them below. Also, copy and paste Learning Objective A below.

Copy and Paste Learning Objective A from above here:

Final Revision of Goal 1:

Final Revision of Goal 2:

Final Revision of Goal 3:

Final Revision of Goal 4:

Step 3: Revise, if necessary, Goals 5, 6, 7 and 8 so that they: 1) state when you will work on your goal; 2) contain a start time that is within the next 2 weeks; and 3) phrased using the following statement: "On (specify day, date, time), I will (specify goal)". You can copy and paste your goals from Activity 3 to the appropriate spaces below and then revise those goals. Even if your goals do not require revision, still paste them below. Also, copy and paste Learning Objective B below.

Copy and Paste Learning Objective B from above here:

Final Revision of Goal 5:

Final Revision of Goal 6:

Final Revision of Goal 7:

Final Revision of Goal 8:

Passage 5

Implementing Your Goals for EDP371

Now that you set 8 useful goals for reaching 2 of your EDP371 learning objectives, you need to go and implement your goals. Over the next 2 weeks, please do your best to stick to your plan and reach these goals.

Before you leave today, you will be given hard and electronic copies of the goals you set. Use these copies to help you stay on track to reaching your goals for EDP371.

Evaluating your Goals for EDP371

Over the next 2 weeks, you will be asked to keep track of your progress towards reaching each of these goals. On four separate occasions over the next 2 weeks, you will be asked to go online and evaluate the progress that you made towards each of your goals. You need to do this: 3 days from today, 7 days from today, 10 days from today, and 14 days from today. You will be sent an e-mail with a link to an internet site where you will be asked to evaluate the progress you made towards each goal. So, please check your e-mail daily so that you make the evaluations on time! They will take only 5 minutes each.

Summary

Congratulations! You just learned more about how to set useful goals for you EDP371 introductory statistics course. In the sections above you used many powerful strategies to improve your goal setting. These strategies included:

- Setting goals focused on the methods and strategies you can use to learn a concept, master a skill, and reach a learning objective in EDP371.
    - Setting goals focused on what to study (course material and information sources).
    - Setting goals focused on how to study (learning strategies and study skills).
- Revising your goals so that they are:
    - Specific and Measurable
    - Challenging yet Realist
    - Contain a start day, date, and time within the next 2 weeks.
    - Phrased using the following statement: "On (specify day, date, time), I will (specify goal)."

You can use these strategies throughout the rest of the semester in your EDP371 course. These strategies can also be used in other courses or in other areas of your life.

Thank you for participating in this project! Please save your work and raise your hand for the facilitator to come around and let you know what to do next.

Appendix D: Self-evaluation Component of the Enhanced Goal Setting Intervention

Instructions

[Note: students made their self-evaluations online. Therefore, the format below is not the same as what students saw.]

[The following are sets of instructions given to students]

This survey asks you about the progress that you have made up until this point towards reaching the 2 learning objectives and 8 goals that you set as part of The Statistics Project.

The usefulness of our research depends upon you carefully and honestly responding to each survey item. Please take your time and answer the items as best as you can. You must complete the entire survey now. Your responses will not be saved if you exit the survey in the middle. Thanks!

Before you begin you must get out either the paper copy or electronic document of your 2 learning objectives (Learning Objectives A and B) and 8 goals (Goals 1-8) which was given to you by the project administrator. If you have any questions, please contact the project administrator: Taylor Acee, (512) 228-6013, aceet@mail.utexas.edu.

Using the scale below, rate the amount of progress that you have already made towards reaching each of the learning objectives (A and B) and goals (1-8) that you set as part of the Statistics Project. First, read your learning objective or goal. Then, rate how much progress you have already made towards reaching it.

[Rating Scale: No progress, A little progress, Some progress, A fair amount of progress, Very much progress]

1. How much progress have you made towards reaching Learning Objective A?

2. How much progress have you made towards reaching Goal 1?

3. How much progress have you made towards reaching Goal 2?

4. How much progress have you made towards reaching Goal 3?

5. How much progress have you made towards reaching Goal 4?

6. How much progress have you made towards reaching Learning Objective B?

7. How much progress have you made towards reaching Goal 5?

8. How much progress have you made towards reaching Goal 6?

9. How much progress have you made towards reaching Goal 7?

10. How much progress have you made towards reaching Goal 8?

[For the following six items students were asked to type their responses into a text box.]

11. List the steps that you have taken so far to reach Learning Objective A (e.g., What information have you studied? What strategies have you used to learn the information? Have you asked anyone for help or studied in groups?).

12. Think about the steps that you have taken so far to reach Learning Objective A and answer the following 2 questions: a) What has worked well for you? b) What has not worked well you?

13. Describe in detail 2 ways that you could increase your success at reaching Learning Objective A.

14. List the steps that you have taken so far to reach Learning Objective B (e.g., What information have you studied? What strategies have you used to learn the information? Have you asked anyone for help or studied in groups?).

15. Think about the steps that you have taken so far to reach Learning Objective B and answer the following 2 questions: a) What has worked well for you? b) What has not worked well you?

16. Describe in detail 2 ways that you could increase your success at reaching Learning Objective B.

Appendix E: Learning Objectives for Course Section A

Instructions: Below are 10 learning objectives that were taken from your course packet and reorganized for this activity. They are focused on the content that will be covered on your next EDP371 exam (Unit 3). These objectives help give you an idea about what your instructor thinks is important and what he expects you to be able to accomplish on the next exam. Choose two objectives that you will be able to work on reaching over the next two weeks and paste them into the electronic workbook. The objectives you choose do not have to be fully completed within two weeks, but you should be able to make progress towards them within that time period. If you need to look at your course schedule to find out what you will be covering in class over the next two weeks, click on the file named "[Course Section A]_Course Schedule". If you have any questions please raise your hand and the facilitator will come over to help you.

Unit 3 Learning Objectives

Related, paired, or dependent samples *t*-test

1. (a) Identify the settings in which it is appropriate to use dependent samples *t*-test. (b) Identify the statistical assumptions for this technique and whether analysis results are robust to violations of the assumptions. (c) Identify the analysis procedures for this technique. (d) Given a description of a study and selected results from an SPSS printout, describe the results clearly in terms of the context of the study.

Independent samples *t*-test

2. (a) Identify the settings in which it is appropriate to use independent samples *t*-test. (b) Identify the statistical assumptions for this technique and whether analysis results are robust to violations of the assumptions. (c) Identify the analysis procedures for this technique. (d) Given a description of a study and selected results from an SPSS printout, describe the results clearly in terms of the context of the study.

Correlation

3. (a) Describe what the correlation coefficient summarizes (magnitude and direction of the linear relationship between two variables.) (b) Sketch and/or interpret sketches of scatter plots depicting positive linear relationships, negative linear relationships, no linear relationship, and curvilinear relationships. (c) State and/or identify the properties of the correlation coefficient.

4. (a) Identify the settings in which it is appropriate to use correlation. (b) Identify the statistical assumptions for this technique and whether analysis results are robust to

violations of the assumptions. (c) Identify the analysis procedures for this technique. (d) Given a description of a study and selected results from an SPSS printout, describe the results clearly in terms of the context of the study.

Simple Linear Regression

5. (a) Interpret each symbol in linear regression equations for predicted and observed scores. Given a scatter plot that has a regression line, label and interpret the following: observed Y scores, observed X scores, predicted Y scores, the intercept, the slope, and residual or error scores. (b) Understand how the best-fitted regression line is derived. (minimizing the sum of squared residuals). (c) Given a value for a regression slope, interpret the slope in raw score and standardized form. (d) Understand how the two model fit indicators (*S.E.E.* and r^2) summarize the fit of the model.

6. (a) Identify the settings in which it is appropriate to use simple linear regression. (b) Identify the statistical assumptions for this technique and whether analysis results are robust to violations of the assumptions. (c) Identify the analysis procedures for this technique. (d) Given a description of a study and selected results from an SPSS printout, describe the results clearly in terms of the context of the study.

Chi-Square Test for Independence

7. (a) Describe what the phi coefficient and Cramer's phi coefficient summarize. (b) Provide the minimum and maximum values of these statistics and indicate when each would be used for the chi-square test of independence. (Summarize strength of association between two variables; 0 and 1.00; phi is used for 2 X 2 tables, Cramer's phi is used for larger contingency tables.) (c) Given the observed frequencies and percents for a 2 X 2 contingency table, interpret percents given in the table.

8. (a) Identify the settings in which it is appropriate to use chi-square test of independence. (b) Identify the statistical assumptions for this technique and whether analysis results are robust to violations of the assumptions. (c) Identify the analysis procedures for this technique. (d) Given a description of a study and selected results from an SPSS printout, describe the results clearly in terms of the context of the study.

General

9. (a) State the general data analysis procedures, listing purposes and activities. (This will be on the Unit 3 Test.) (b) Define robustness and describe why we are concerned about violations of assumptions. (c) Distinguish between experiments, quasi-experiments, and non-experiments. (d) Describe the activities that are to be carried out when an outlier is found, including the activities and purpose associated with a sensitivity study.

10. Identify the primary differences between dependent samples t-tests, independent samples t-tests, correlation, simple linear regression, and chi-square test for independence, in terms of analysis goals, hypotheses tested, and effect size measures used.

Appendix F: Learning Objectives for Course Section B

Instructions: Below are 9 learning objectives that were taken from your course syllabus and reorganized for this activity. They are focused on the content that will be covered on your next EDP371 exam (Units 7-12). These objectives help give you an idea about what your instructor thinks is important and what he expects you to be able to accomplish on the next exam. Choose two objectives that you will be able to work on reaching over the next two weeks and paste them into the electronic workbook. The objectives you choose do not have to be fully completed within two weeks, but you should be able to make progress towards them within that time period. If you need to look at your course schedule to find out what you will be covering in class over the next two weeks, click on the file named "[Course Section B]_Course Schedule". If you have any questions please raise your hand and the facilitator will come over to help you.

Learning Objectives for Units 7-13

Unit 7-8: Probability and Sampling Distributions

1. Identify and/or be able to provide definitions and interpretations of: (a) probability, random process, simulation, and random variable (continuous, discrete, dichotomous, binomial) (Unit 7); and (b) parameter, statistic, population, sample bias, sampling distributions and the central limit theorem (Unit 8).

Unit 9: Inference about means

2. (a) Identify and/or be able to provide definitions and interpretations of null vs. alternative (H_0 and H_1) hypotheses. (b) Given a hypothetical statement, classify this statement as being a null hypothesis, an alternative hypothesis, or neither a null nor alternative hypothesis. (c) Distinguish between correct and incorrect definitions, interpretations, and illustrations of a confidence interval. (d) Recognize the relationship between sample size, accuracy, and confidence. (e) Establish confidence intervals for one mean.

Unit 10: Comparing two treatments

3. (a) Apply hypothesis testing procedures to significance of difference between means using both paired and independent samples *t*-tests. (b) Distinguish between correct and incorrect interpretations of statistically significant and insignificant conditions. (b) Establish confidence intervals for difference between two independent means. (c) Given a description of a research problem, describe what a researcher must do related to the statistical analysis and interpretation of results for both paired and independent samples *t*-

tests. (d) Given a brief written statement of someone else's interpretation of a statistic, identify any basic statistics-related flaws that may be present in the interpretation.

Unit 11: ANOVA

4. (a) Apply hypothesis testing procedures to one-way analysis of variance. (b) Distinguish between correct and incorrect interpretations of statistically significant and insignificant conditions. (c) Given a description of a research problem, describe what a researcher must do related to the statistical analysis and interpretation of results for ANOVA. (d) Given a brief written statement of someone else's interpretation of a statistic, identify any basic statistics-related flaws that may be present in the interpretation.

Unit 12: Relationships

5. (a) Identify the approximate degree of relationship (e.g. low positive or high negative) when given either a scatter plot or a set of raw-scores or standard scores on two variables. (b) Given a set of raw-scores or standard scores on two variables, calculate the (Pearson) product-moment coefficient. (c) Interpret a correlation coefficient in terms of explained and unexplained variance.

6. (a) Given the correlation coefficient, and the mean and standard deviation for the independent and dependent variables, calculate the regression equation and standard error of estimate. (b) Establish confidence intervals for simple linear slope (correlation) coefficient. (c) Identify and/or be able to provide definitions and common applications of a regression equation, and of standard error of estimate. (d) Identify and/or be able to provide illustrations of these concepts: least squares, slope, intercept, linear and curvilinear relationships, normal distribution, homoscedasticity, and outlier.

7. (a) Distinguish between correct and incorrect interpretations of statistically significant and insignificant conditions for both correlation and regression analyses. (b) Given a description of a research problem, describe what a researcher must do related to the statistical analysis and interpretation of results for both correlation and regression analyses. (c) Given a brief written statement of someone else's interpretation of a statistic, identify any basic statistics-related flaws that may be present in the interpretation.

Unit 13: Categorical Data

8. (a) Apply hypothesis testing procedures to significance of departure from independence of two nominal variables, using a chi-squared test. (b) Distinguish between correct and incorrect interpretations of statistically significant and insignificant conditions. (c) Given a description of a research problem, describe what a researcher

must do related to the statistical analysis and interpretation of results for a chi-squared test. (d) Given a brief written statement of someone else's interpretation of a statistic, identify any basic statistics-related flaws that may be present in the interpretation.

General Objective:

9. Given a description of a research problem, identify the appropriate statistical procedure: paired samples t-tests, independent samples t-tests, ANOVA, correlation, regression, and chi-squared test.

Appendix G: Enhanced Value Reappraisal Intervention (VR-E)

Instructions

This electronic workbook is designed to help you consider how learning and developing skills in your EDP371 introductory statistics course can be of value to you. Please read through the entire workbook from beginning to end and complete every activity along the way. Type your responses to the activities in the spaces provided (marked in green). At any time if you have a question, raise your hand and the facilitator will come over to help you. Please do not rush and take as much time as you need. The usefulness of our research and the benefits it may bring to you and statistics students in the future depends upon you carefully and honestly reading and responding to the material presented below.

Introduction

Being successful at anything begins with having a positive attitude. Consider the 1999 – 2005 Tour de France winner, Lance Armstrong, who fought a difficult battle with cancer. Without a positive mental attitude, would he have been able to overcome a life-threatening disease and then go on to win one of the most grueling events in sports for seven years in a row? No matter what you set out to do, the journey begins with your attitude. You need to feel and believe that what you are doing is important. You must also want to do it and be willing to do what it takes to succeed.

Many students enter statistics courses with a negative attitude towards the subject; thinking that statistics is uninteresting and of little importance. Research has demonstrated time and again that a negative attitude plays a large role in keeping otherwise successful students from performing well in their statistics courses. Using the information, suggestions, and strategies presented in this workbook, you can improve your attitude, become more motivated and achieve at a higher level in your EDP371 introductory statistics course.

Passage 1

<u>What is a Good Attitude and Why is it Important to Have One in EDP371?</u>

Characteristics of Students with Positive Attitudes Toward Their EDP371 Statistics Course

In this section, we will identify what you already know about students who have positive attitudes toward their EDP371 statistics course. We will also discuss what research and other students have to say about such students.

We will begin by examining your opinions about students who have positive attitudes towards their EDP371 course.

Activity 1a:
Write 2 examples of how students with positive attitudes towards EDP371 might feel, think, and work toward successfully completing their coursework.

Example 1:

Example 2:

Let's look at the findings from research and the reports of students with positive attitudes about their courses. What do they say about the ways these students feel, think, and behave?

- Students with positive attitudes towards EDP371 have generally positive feelings and beliefs about the course and course-related activities.
- They see how learning statistical concepts and skills can help them to achieve their personal, academic, and work/occupational goals.
- They want to participate during class.
- Students with positive attitudes towards EDP371 are able to focus and maintain their attention during class and while completing assignments.
- They remember what they studied for EDP371 and apply what they learned when they come across statistics in everyday life.
- Students with positive attitudes about learning their statistics coursework are willing to do what is necessary to reach their goals for EDP371.

Characteristics of Students with Negative Attitudes Toward Their EDP371 Statistics Course

Now let's look at students who have negative attitudes toward their courses. We want you to state some of your opinions about such students in the activity below.

Activity 1b:

Write 2 examples of how students with negative attitudes toward their courses might feel, think, and work toward successfully completing their coursework.

Example 1:

Example 2:

Let's look at the findings from research and the reports of students with negative attitudes about their courses. What do they say about the ways these students feel, think, and behave?

- Students with negative attitudes towards EDP371 may have negative feelings or doubts about the usefulness of learning statistics and developing skills for statistical problem solving, thinking, and reasoning.

- They may avoid participating fully in their EDP371 statistics coursework because they don't see how it is relevant to their personal, academic, and work/occupational goals.

- They may feel that EDP371 coursework is a waste of their time.

- Students with negative attitudes towards learning statistics may find it difficult to stay focused during class and on EDP371 course assignments.

- They may have trouble understanding course content and applying it to the statistics they come across in everyday life.

- They may not be motivated to put forth the effort necessary to succeed in EDP371.

What Are Your Attitudes Towards Your EDP371 Introductory Statistics Course?

Your attitudes towards EDP371 are based on many things such as:

- How much you like or dislike the course.

- How valuable you perceive the content of the course as being for you.

- How important you think learning the course material is for reaching your future personal, academic, and work/occupational goals.

- How important passing the course is for reaching your future goals.
- How much you want to perform well in the course.
- How willing you are to do the necessary work to succeed in the course.

Activity 1c:

A. Explain in detail (at least 2-3 sentences) what you believe your attitude is towards your EDP371 introductory statistics course (you can use the above descriptions of what an attitude is based on to help structure your answer)?

Type Here:

B. Explain in detail (2-3 sentences) how you think your attitude may positively, or negatively, affect your learning and performance in EDP371.

Type Here:

Attitude: An Important Factor In Succeeding

A person's attitude is one of the most important factors associated with success. In every professional area (e.g., advertising, business, communications, education, entertainment, government, health, law, military, natural science, nursing, psychology, social science, sports, etc.) successful people think what they are doing is important and useful, they believe they can succeed, and they maintain the energy, interest, and focus required to succeed. It is not always easy, but most successful people accept and face challenges in order to accomplish their most important and meaningful goals.

Your attitude towards your EDP371 introductory statistics course directly impacts your motivation and success in the course. You will be more likely to put forth the effort needed to complete your coursework if you have a positive attitude towards the course and understand why learning the course material might be important for you.

The reading passages and activities in this workbook are designed to help you improve your attitude toward your EDP371 introductory statistics course so that you understand how learning statistics is important for you and become more motivated and successful at learning your EDP371 course material. This begins with you becoming aware of your own attitude towards EDP371 and understanding how it affects your studies. It also involves deeply considering the various ways that developing statistical knowledge and skills could be important for you now and in the long-run. So let’s get started.

Passage 2

Finding Meaning in Your EDP371 Coursework

Research has suggested that students who are motivated to learn the content of their statistics courses are more likely to learn and succeed in those courses than students who just want to get a good grade, impress others, or avoid failing. Being motivated to learn EDP371 course content begins with an understanding of why learning that content is important and useful for you. Looking for ways that the content of your statistics course may be meaningful to you can help you to develop a more positive attitude towards your EDP371 and improve your success in the course. There are various reasons why learning the content presented in your EDP371 introductory statistics course could be important for you. Let's start by exploring what types of knowledge and skills you can develop from learning the content presented in EDP371.

What Types of Knowledge and Skills Can you Develop in EDP371

Learning the content presented in your EDP371 introductory statistics course can help you develop various types of knowledge and skills. Take a moment to consider some of the knowledge and skills that you think you can develop in EDP371.

Activity 2a:

Below, list 5 examples of knowledge and skills that you believe you could develop by learning the information presented in your EDP371 introductory statistics course.

Example 1:

Example 2:

Example 3:

Example 4:

Example 5:

Now, let's review some suggestions provided by other students and teachers.

Learning the content presented in your statistics course can help you to become more knowledgeable about:

- How statistics are generated and used to answer questions and solve problems.

- The meaning of statistical terms (e.g., mean, medium, mode, standard deviation, variance, hypothesis, correlation, causation, t-test, and regression).

- The difference between correlation and causation.

- How to gather evidence to test hypotheses and answer research questions.

- How to interpret statistics that you come across in everyday life (e.g., statistics in magazines, news reports, advertisements and on television).

- How to not misunderstand, or be fooled by, reports or research findings based on statistics.

- Statistical concepts or procedures that might be important for your future occupation.

Statistics also involves research, mathematics, and problem solving. Therefore, your introductory statistics course can help you to develop and improve your skills in:

- Research

- Mathematics

- Statistical Thinking and Problem Solving

- Generating Statistics

- Interpreting Graphs and Tables

- Interpreting Statistically Based Information
- Using statistics to answer questions and solve problems

- Performing Statistical Tests

- Reading Statistical Information Presented in Articles in Newspapers, Magazines, etc.

Learning the content of your EDP371 statistics course can also help you to develop skills related to becoming a better learner in general. Therefore, putting effort into learning the content of your statistics course can give you practice in developing more general learning skills such as:

- Keeping up with a study schedule

- Staying focused on your studies
- Paying attention during class
- Motivating yourself to learn
- Selecting main ideas
- Testing yourself to make sure you learned something well enough
- Understanding abstract concepts
- Making meaning out of mathematical formulas
- Using formulas to solve problems
- Solving word problems

You can practice developing all of the skills mentioned above (and many more) simply by trying to learn the information presented in your introductory statistics course.

Now you should have a better idea about the types of knowledge and skills that you can develop as a result of learning the content of your EDP371 statistics course. Let's consider why developing these knowledge and skills may be important for you.

Why is it Important to Develop Knowledge and Skills Related to EDP371 Statistics

Take a moment to consider how developing knowledge and skills related to your EDP371 statistics course may be important for you in other areas of your life (academics, occupational, social, and personal).

Activity 2b:

A. List at least 4 ways in which developing knowledge and skills related to your EDP371 statistics course could be beneficial for you (feel free to consider benefits to your academic, occupational, social, and personal goals).

Type Here:

B. Using the list you created above, choose the most important benefit for improving your knowledge and skills in statistics and list it below.

Type Here:

C. Think about the benefit you listed above and imagine events or experiences related to it in your thoughts as intensively as possible! Let the mental images pass by in your thoughts and do not hesitate to give your fantasies free reign. Take as much time and space as you need to describe your thoughts.

Type Here:

D. Using the list you created above, choose the second most important benefit to improving your knowledge and skills in statistics and list it below.

Type Here:

E. Think about the benefit you listed above and imagine events or experiences related to it in your thoughts as intensively as possible! Let the mental images pass by in your thoughts and do not hesitate to give your fantasies free reign. Take as much time and space as you need to describe your thoughts.

Type Here:

Now let's explore various other reasons why learning the content of your statistics course may be important for you.

Passage 3

Becoming an Intelligent Consumer of Statistical Information

Statistics is more frequently used today than ever before. Statistics is used in almost every profession: advertising, business, communications, education, entertainment, government, health, law, military, natural science, nursing, psychology, social science, sports, etc. You can't pick up a newspaper or magazine, or listen to the radio or television, without coming across a statistic.

- "4 out of 5 dentists use Crest toothpaste"
- "People who eat fruit regularly are 20% more likely to avoid the flu"
- "A research study found that people tend to be more persuasive when they look others directly in the eye and speak loudly and quickly"
- "The Educational Psychology Department at the University of Texas is ranked 6th in the nation"

Not only do we encounter a lot of statistics, we also base many of our decisions on statistics. For example, people often use statistically based information they read in health reports to adjust their eating and exercise habits. Unfortunately, however, statistics can often be misleading. Sometimes statistics are misleading because we don't know enough about statistics to interpret them correctly. Consider the following two statistical facts:

- Children with bigger feet spell better
- Nations that add fluoride to their water have a higher cancer rate than those that don't.

Based on this information should we begin stretching our children's feet? Should we stop adding fluoride to our water?

Although studies do exist which establish the above findings, it doesn't necessarily mean that having bigger feet causes one to be a better speller. Nor does it mean that drinking fluoride causes cancer. The difference here is between correlation and causation. Often time things can be correlated because of a third factor.

The odd results above are easily explained with a third factor - age. Children with bigger feet spell better because they're older. And those nations that add fluoride to their water are generally wealthier and more health-conscious, and thus a greater percentage of their citizens live long enough to develop cancer. Understanding basic ideas related to statistics, such as the difference between correlation and causation, can help you to avoid making misinterpretations of the statistical information you read and use.

Another reason people misinterpret statistics is because, at times, people present statistics in ways that are intended to be misleading and manipulative. Consider the following quote:

Political tacticians are not in search of scholarly truth or even simple accuracy. They are looking for ammunition to use in the information wars. Data, information, and knowledge do not have to be true to blast an opponent out of the water.

—Alvin Toffler

Toffler may be overly cynical in his point of view, but in reality, people and organizations do manipulate information for their own uses. For this reason, you should always be critical about the information that is provided to you. Learning more about statistics can help you distinguish between statistical information that is reliable and that which is not.

Overall, it may be important for you to learn more about statistics so you can become a more intelligent consumer of the statistical information that you read and use daily. Take

a moment to consider the types of statistical information you have used in the past or will use in the future.

Activity 3:

A. Give one example (2-3 sentences) describing a time when you used statistically based information in the past to learn more about a topic or make a decision.

    Type Here:

B. Give one example (2-3 sentences) describing when you may use statistically based information in the future to learn more about a topic or make a decision.

    Type Here:

C. Explain why you do or do not think developing knowledge and skills related to your EDP371 introductory statistics course could help you to become a more intelligent consumer of statistically based information (at least 2 sentences)?

    Type Here:

Passage 4

Relevance to your Other Courses

Knowledge and skills related to statistics can be important when participating in other courses. For example, learning statistical formulas presented to you in EDP371 could help you to more easily learn your coursework in other statistical, research or math-based courses that you are currently taking or will need to take in the future. Therefore, developing knowledge and skills related to your introductory statistics course could help you to be more successful in your other courses. Take a moment to consider the courses you plan on taking and how learning your EDP371 course material could help prepare you for these courses.

Activity 4:

A. List 4 courses that you plan on taking in which your learning would be improved if you had developed knowledge and skills related to your EDP371 introductory statistics course.

    Type Here:

B. From your list above, choose the one course in which your learning would be most improved if you had developed knowledge and skills related to your EDP371 introductory statistics course

Type Here:

C. Explain why you do or do not think developing knowledge and skills related to your EDP371 introductory statistics course could help you when participating in the course you described above (2-3 sentences).

Type Here:

Passage 5

Relevance to your Occupation

Many jobs require the use of knowledge and skills related to statistics. For example:

- Sports announcers often use statistics to report facts and to analyze the status of players and their teams.
- Health care workers (nurses, doctors, etc.) use the statistics they read in medical reports to inform their patients about important health information.
- Educators use statistics and math to assign students grades and evaluate their school's standings compared with other schools.
- Business professionals use statistics to make investment decisions and solve problems.
- Advertisers use research and statistics to decide which adds to use for their products.
- Social scientists use statistics to assess public demographics and opinions and to evaluate social programs.
- Psychologists use statistics to interpret data from their research studies.
- Natural scientists use statistics to help estimate and predict phenomena in the natural world.

- Government representatives and employee's use local and national statistics to identify problems and evaluate solutions to various social, health, and economic issues.

Your profession may also involve the use of knowledge and skills related to statistics. Therefore, developing knowledge and skills in your introductory statistics course could be very useful for you. Take a moment to consider various occupations that you are currently interested in pursing and how statistics might be used in those professions.

Activity 5:

A. List 4 occupations that you are currently interested in pursing.

   Type Here:

B. From your list above, choose one occupation that would involve the use of knowledge and skills related to statistics.

   Type Here:

C. Describe (2-3 sentences) the ways in which you see knowledge and skills relate to statistics being used in that occupation.

   Type Here:

D. Explain (2-3 sentences) the ways that your EDP371 introductory statistics course may help you in attaining knowledge and skills related to the occupation you listed above.

   Type Here:

Passage 6

Challenge, Interest, and Enjoyment

Another reason why learning statistics could be important to you is because it can be challenging, interesting, and enjoyable.

For example:

- Many students find that it feels good when their hard work results in understanding a concept, developing a skill, or successfully solving a problem.

- Other students find statistics to be interesting and enjoy learning more about it.

- Some students find that they enjoy working on their statistics coursework with their classmates in study groups or during in-class activities.

- Some students make studying statistics more enjoyable by turning it into a game that (e.g., seeing how many problems they can complete in an hour).

- Other students make learning statistics more interesting by relating it to the statistics they come across in everyday life (e.g., statistics about their favorite sports players or statistics presented to them in magazines)

- Students also make learning statistic more interesting by thinking about how the statistics they are studying could be used to help answer a question that they have about society and the world (e.g., Are men or women more at risk for heart disease? What is the average amount of time it takes for students to complete their master's degree in education).

There may be various aspects of your EDP371 introductory statistics course that you find interesting or enjoyable. There may also be ways you can make your learning statistics more interesting and enjoyable to you.

Activity 6a:

A. Give one detailed example of a time when you felt interest or enjoyment related to your introductory statistics course (2-3 sentences).

   Type Here:

B. Describe 2 ways that you think you could increase your interest and enjoyment of learning statistics. (You can refer to the section above about the strategies other students have used to increase their interest and enjoyment of learning statistics).

   Type Here:

Another way to develop more interest and enjoyment for statistics is to change your negative thoughts about EDP371 into more positive thoughts. Having negative thoughts about your EDP371 statistics course will inevitably make statistics less interesting and enjoyable. You have the power to control you own thoughts and make them more positive. One way to do this is by identifying the negative thoughts you have, figuring out why you have those thoughts, and replacing those thoughts with positive thoughts. The following activity is designed to walk you through these steps.

Activity 6b:

A. Take a moment to reflect about the experiences you have had related to your statistics course or other statistics courses in the past. In the spaces below, describe in detail 2 negative thoughts that you have had related to statistics.

Negative Thought 1:

Negative Thought 2:

B. Take a moment to consider how these negative thoughts have affected you (you can consider how they have affected your course performance, enjoyment of the subject, or anything else that comes to mind). In the spaces below, give a detailed explanation about how the two negative thoughts you listed above may have affected you.

The Effect of Negative Thought 1:

The Effect of Negative Thought 2:

C. Take a moment to consider how you might be able to change these negative thoughts into more positive thoughts. In the spaces below, transform the two negative thoughts you listed above into positive thoughts.

Positive Thought 1:

Positive Thought 2:

D. Imagine that you are experiencing Negative Thought 1 sometime in the future. Let the mental images pass by in your thoughts and do not hesitate to give your fantasies free reign. Then imagine yourself replacing Negative Thought 1 with Positive Thought 1. Imagine this as intently as possible! Take as much time and space as you need to describe your thoughts below.

Type Here:

E. Explain in detail what consequences you think would occur from changing your negative thoughts about statistics into more positive thoughts?

Type Here:

Summary

You have just considered many of the reasons why the content of your EDP371 statistics course could be important for you. More specifically, we discussed how your EDP371 introductory statistics course could help you to become:

- A more intelligent consumer of statistical information
- More skilled in statistical thinking, research, mathematics, and problem solving
- More skilled at learning and managing your learning in general
- More knowledgeable and skilled in your future courses and occupation
- We discussed how statistics can be challenging, interesting, and enjoyable
- We also discussed how you can increase your interest and enjoyment of statistics by changing your negative thoughts into positive thoughts.
- There may also be many other reasons why learning statistics is important for you that you came up with on your own.

Passage 7

Integrating what you Have Learned

The following 2 activities are designed to help you further process, summarize, and integrate what you have learned from the activities and information presented above. Try to engage intensely in these next 2 activities. They require a deeper level of integrating your ideas and could be very useful for you.

Activity7a:

A. Using what you learned so far, create a convincing argument explaining why developing knowledge and skills related to your introductory statistics course <u>is</u> valuable for you and type it below (3-5 sentences).

Type Here:

B. Using what you learned so far, create a convincing argument explaining why developing knowledge and skills related to your introductory statistics course <u>is not</u> valuable for you and type it below (3-5 sentences).

Type Here:

C. Which of the arguments that you provided above do you more strongly believe? Give a detailed explanation addressing why you believe one argument more strongly than the other (if you cannot decide what argument you prefer, explain why). Type your answer below (3-5 sentences).

Type Here:

Activity 7b:

A. Below, list in order the 2 most important benefits related to improving your knowledge and skills in your EDP371 introductory statistics course.

First:

Second:

B. Now, consider all the obstacles standing in your way of improving your knowledge and skills related to your statistics course. List 8 obstacles that you believe you could make progress in overcoming if you put in the necessary effort.

Type Here:

C. From the list you created above list in order the 2 obstacles that you believe are the most important for you to overcome in order to improve your knowledge and skills related to statistics.

First:

Second:

D. Think about the first benefit you listed above in part A and imagine events or experiences related to it in your thoughts as intensively as possible! Let the mental images pass by in your thoughts and do not hesitate to give your fantasies free reign. Take as much time and space as you need to describe your thoughts.

Type Here:

E. Think about the first obstacle you listed above in Part C and imagine events or experiences related to it in your thoughts as intensively as possible! Let the

mental images pass by in your thoughts and do not hesitate to give your fantasies free reign. Take as much time and space as you need to describe your thoughts.

Type Here:

F. Now imagine step-by-step how you would go about overcoming that obstacle. Vividly live out the events or experiences related to overcoming that obstacle in your thoughts as intensively as possible! Take as much time and space as you need to describe your thoughts.

Type Here:

G. Think about the second benefit you listed above in Part A and imagine events or experiences related to it in your thoughts as intensively as possible! Let the mental images pass by in your thoughts and do not hesitate to give your fantasies free reign. Take as much time and space as you need to describe your thoughts.

Type Here:

H. Think about the obstacle you listed above in Part C and imagine events or experiences related to it in your thoughts as intensively as possible! Let the mental images pass by in your thoughts and do not hesitate to give your fantasies free reign. Take as much time and space as you need to describe your thoughts.

Type Here:

I. Now imagine step-by-step how you would go about overcoming that obstacle. Vividly live out the events or experiences related to overcoming that obstacle in your thoughts as intensively as possible! Take as much time and space as you need to describe your thoughts.

Type Here:

Congratulations! You just learned more about creating a positive attitude towards you statistics course. In the sections above you used many powerful strategies to improve your attitude towards you statistics course. These strategies included:

- Listing the varied knowledge and skills that you can learn from your statistics course.
- Thinking about your attitudes about your statistics course and how it affects your success in the course.

- Replacing negative thoughts that you have about statistics with more positive thoughts.

- Searching for ways that learning statistics and developing skills in statistical problem solving, thinking, and reasoning can help you reach your other personal, academic, and work/occupational goals.

- Imagining benefits related to developing statistical knowledge and skills.

- Explaining what you value about learning statistics in EDP371.

- Thinking about obstacles standing in your way of improving in your statistics course and imagining how you will overcome them in the future.

You can use these strategies throughout the rest of this semester in your EDP371 course. These strategies can also be used in other courses or in other areas of your life.

Thank you for participating in this project! Please save your work and raise your hand for the facilitator to come around and let you know what to do next.

Appendix H: Control Condition (C)

Instructions

This document will direct you in going online and completing three Texas Information Literacy Tutorial Modules. These three modules will introduce you to general concepts about the library and Internet research that might be important for your success as a college student. At the end of each module there is a nine-question quiz. If you do not earn 100% on the quiz the first time, continue to retake it until you do. When you earn 100%, e-mail the results to the facilitator (aceet@mail.utexas.edu) using the e-mail function within the Module. After you complete a module, return to this document and type your responses to the three questions about that module in the spaces provided (marked with green font).

Please work your way through this entire document from start to finish and do not skip any steps. At any time if you have a question, raise your hand and the facilitator will come around to help you. Please do not rush and take as much time as you need. The validity of our research depends upon your thorough engagement with the material presented below.

Scroll down to the next page.

Module 1: Selecting – learn to select sources appropriate for academic research

1) Go to the following website: http://tilt.lib.utsystem.edu
2) Click "Full TILT" at the bottom right-hand side of the page.
3) Click "and enter TILT" at the very bottom of the page.
4) Click "First Time Visitors"
5) Enter all your information and click "Register"
6) Go through the introduction
7) Complete all of Module 1
8) Earn 100% on the Module 1 quiz (you can retake the quiz until you get 100%) and send your results to: aceet@mail.utexas.edu

Activity 1

Please complete the three items below about Module 1 before going onto Module 2.

A. Summarize, in your own words, the purpose of Module 1.

Type Your Response Here:

B. Describe at least three things that you learned from completing Module 1.

Type Your Response Here:

C. Describe one future situation in which you will use what you learned from Module 1.

Type Your Response Here:

Module 2: Searching – learn to effectively search library databases and the Web

1) Complete all of Module 2
2) Earn 100% on the Module 2 quiz and send your results to: aceet@mail.utexas.edu

Activity 2:

Please complete the three items below about Module 2 before going on to Module 3.

A. Summarize, in your own words, the purpose of Module 2.

Type Your Response Here:

B. Describe at least three things that you learned from completing Module 2.

Type Your Response Here:

C. Describe one future situation in which you will use what you learned from Module 2.

Type Your Response Here:

Module 3: Evaluating – learn how to locate and evaluate print and online sources.

1) Complete all of Module 3

2) Earn 100% on the Module 3 quiz and send your results to: aceet@mail.utexas.edu

Activity 3:

Please complete the three items below about Module 3.

A. Summarize, in your own words, the purpose of Module 3.

Type Your Response Here:

B. Describe at least three things that you learned from completing Module 3.

Type Your Response Here:

C. Describe one future situation in which you will use what you learned from Module 3.

Type Your Response Here:

Congratulations! You just learned more about and developed skills in selecting, searching and evaluating print and online information sources.

You can use these strategies in your college courses and in other areas of your life.

Thank you for participating in this project! Please save your work and raise your hand for the facilitator to come around and let you know what to do next.

Appendix I: Debriefing of Study Participants

The U.S. Department of Education and National Science Foundation have identified that there are growing economic and social needs to increase students' achievement and continued interest in math and science education; and that these needs are particularly strong for underrepresented ethnic minorities and women. While much educational intervention research has focused on helping students build their confidence and improve their academic achievement, much less intervention research has focused on helping students to place value on and develop a continued interest in a particular subject area. The purpose of the Statistics Project was to examine the effects of two educational interventions with different foci on female students' continued interest and achievement in their undergraduate, introductory statistics courses – a subject that involves both math and science. A control condition was also included so that the effects of these two interventions could be examined.

As part of this project students were randomly assigned to one of three educational interventions. The Goal Setting Intervention was focused on helping students set useful short-term goals for reaching two of the learning objectives for the upcoming exam in their statistics course. The Value Reappraisal Intervention guided students in exploring the importance of becoming an intelligent consumer of statistics in everyday life, academic and professional uses of statistics, and the intrinsic enjoyment of learning statistics. Unlike the other interventions, the Control Condition was not related to students' introductory statistics course, but, was designed to help prepare students for courses that require literature reviews by teaching them how to select, search, and

evaluate print and online sources. It was hypothesized that goal setting would help students increase their confidence for course success and exam performance, whereas, value reappraisal was hypothesized to help students increase the importance they place on learning statistics and help them generate motivation to continue learning statistics even after the course is over.

This dissertation study could help to address the growing economic and social needs for theory-based educational interventions that target the improvement of college students' achievement and continued interest in math and science education. Findings from this research could also help to integrate research on expectancy-value and self-regulation theories by investigating the differential effects of goal setting and value reappraisal on students' confidence for success, values for learning, achievement, and continued interest in a subject area. In addition, this dissertation could help to inform instruction and interventions aimed at helping women learn and become motivated towards statistics.

If you are interested in completing either or both of the interventions you did not receive as part of this project, please e-mail the project administrator with your request and the intervention(s) will be sent to you via e-mail. You can also request a summary of the final results of this study which should be available by February 2009.

Thanks again for all your help!

Project Administrator's Contact Information:

Taylor W. Acee, aceet@mail.utexas.edu, (512) 228-6013

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